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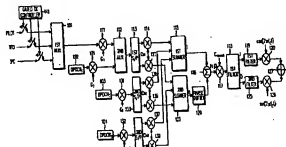
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(54) Method for gated transmission in a CDMA communication system

(57) A method and device for gating the transmission of dedicated control channels in a CDMA communication system is disclosed. In the device and method, if a base station (mobile station) determines whether there is no data to transmit to a mobile station (base station) for predetermined period of time, the base station (mobile station) gates transmission of control information according to a predetermined pattern on a dedicated control channel, which is used for transmitting control information to the mobile station (base station). Control information transmitted from the base station to the mobile station includes Transport Format Combination Indicator (TFCI), Transmit Power Control (TPC), and a pilot symbol. Control information transmitted from the mobile station to the base station includes TFCI, TPC, a pilot symbol, and FeedBack Information (FBI) for information about a transmit diversity antenna system. In a downlink DPCCCH, transmission of the TFCI, TPC and pilot symbol of the predetermined n slots out of total slots of frame can be transmitted discontinuously during gated transmission. Alternatively, transmission of a pilot symbol of the predetermined n th slots and TFCI and TPC of $(n+1)$ th slots can be transmitted discontinuously. In an uplink DPCCCH, transmission of all the TFCI, TPC, FBI and pilot symbol of a specific slot are transmitted discontinuously during gated transmission. In addition, transmission of TPC for power control can be

continuously transmitted for full rate power control when the traffic data is for transmission.

FIG. 10A



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Description

BACKGROUND OF THE INVENTION**1. Field of the Invention**

[0001] The present invention relates generally to a CDMA mobile communication system, and in particular, to an apparatus and method for gated transmission which does not require a separate resynchronization process by assigning dedicated channels.

2. Description of the Related Art

[0002] A conventional CDMA (Code Division Multiple Access) mobile communication system primarily provides a voice service. However, the future CDMA mobile communication system will support the IMT-2000 standard, which can provide high-speed data service as well as voice service. More specifically, the IMT-2000 standard can provide high-quality voice service, moving picture service, an Internet search service, etc.

[0003] In a mobile communication system, data communication is typically characterized by bursts of data transmissions alternating with long non-transmission periods. The bursts of data are referred to as "packets" or "packages" of data. In the future mobile communication system, traffic data is transmitted over a dedicated traffic channel for a data transmission duration, and the dedicated traffic channel is maintained for a predetermined time even when the base station and the mobile station have no traffic data to transmit. The mobile communication system, after finishing transmitting traffic data over the dedicated traffic channel, maintains the down link and up link channels between the base station and the mobile station for a predetermined time even though there is no traffic data to transmit. This is done in order to minimize the time delay due to sync reacquisition when there is traffic data to transmit.

[0004] The invention will be described with reference to a UTRA (UMTS (Universal Mobile Telecommunications System) Terrestrial Radio Access) mobile communication system. Such a mobile communication system requires many states according to channel assignment circumstances and state information existence/nonexistence in order to provide a packet data service as well as a voice service. For example, a state transition diagram for a cell connected state, a user data active substate and a control-only substate are well defined in 3GPP RAN TS S2 series S2.03, 99.04.

[0005] FIG. 1A shows state transition in the cell connected state of the mobile communication system. Referring to FIG. 1A, the cell connected state includes a paging channel (PCH) state, a random access channel (RACH)/downlink shared channel (DSCH) state, a RACH/forward link access channel (FACH) state, and a dedicated channel (DCH) DCH, DCH/DCH+DSCH, DCH/DSCH+DSCH Ctrl (Control Channel) state.

[0006] FIG. 1B shows a user data active substate and a control-only substate of the DCH/DCH, DCH/DCH+DSCH, DCH/DSCH+DSCH Ctrl state. It should be noted that the novel gated transmission device and method is applied to a situation which has no traffic data for a predetermined time.

[0007] The existing CDMA mobile communication system, which mainly provides voice service, releases a channel after completion of data transmission and connects the channel again when there is further data to transmit. However, when providing packet data service as well as voice service, the conventional data transmission method has many delaying factors such as reconnection delay, thus making it difficult to provide high-quality service. Therefore, to provide packet data service as well as voice service, an improved data transmission method is required. For example, in many cases, data transmission is performed intermittently, such as for Internet access and file downloading. Therefore, there occurs a non-transmission period between transmissions of packet data. During this period, the conventional data transmission method releases or maintains the dedicated traffic (or data) channel. If the dedicated traffic channel is released, a long time is required in order to reconnect the channel, and, if the dedicated traffic channel is maintained, channel resources are wasted and reverse power is wasted. To solve such problems, a dedicated control channel is provided between the base station and the mobile station so that for the data transmission period, a control signal related to the dedicated traffic channel is exchanged and for the non-transmission period, the dedicated traffic channel is released and only the dedicated control channel is maintained. Such a state is referred to as the "control-only substate".

[0008] A downlink (or forward link) for transmitting signals from the base station to the mobile station includes the following physical channels. A description of the physical channels which depart from the scope of the invention will be avoided for simplicity. The physical channels involved in the invention include a dedicated physical control channel (hereinafter, referred to as DPCCCH) in which pilot symbols are included for sync acquisition and channel estimation, and a dedicated physical data channel (hereinafter, referred to as DPDCH) for exchanging traffic data with a specific mobile station. The downlink DPDCH includes the traffic data, and the downlink DPCCCH includes, at each slot (or power control group), transport format combination indicator (hereinafter, referred to as TFCI) which is information about the format of transmission data, transmit power control (hereinafter, referred to as TPC) information which is a

power control command, and control information such as the pilot symbols for providing a reference phase so that a receiver (the base station or the mobile station) can compensate the phase. The DPDCH and the DPCCH are time multiplexed within one power control group in down link, and the DPDCH and the DPCCH are separated by orthogonal codes each other in up link.

[0009] For reference, the invention will be described with reference to the case where the frame length is 10msec and each frame includes 16 power control groups, i.e., each power control group has a length of 0.625msec. Alternatively, the invention will also be described with reference to another case where the frame length is 10msec and each frame includes 15 power control groups, i.e., each power control group has a length of 0.667msec. It will be assumed herein that the power control group (0.625msec or 0.667msec) has the same time period as the slot (0.625msec or 0.667msec). The power control group (or slot) is comprised of pilot symbol, traffic data, transmission data-related information TFCI, and power control information TPC in down link. The values stated above are given by way of example only.

[0010] FIG. 2A shows a slot structure including the downlink DPDCH and DPCCH. In FIG. 2A, although the DPDCH is divided into traffic data 1 (Data1) and traffic data 2 (Data2), there is a case where the traffic data 1 does not exist and only the traffic data 2 exists according to the types of the traffic data. Table 1 below shows the symbols constituting the downlink DPDCH/DPCCH fields, wherein the number of TFCI, TPC and pilot bits in each slot can vary according to a data rate and a spreading factor.

[0011] Unlike the downlink DPDCH and DPCCH, uplink DPDCH and DPCCH for transmitting signals from the mobile station to the base station are separated by channel separation codes.

[0012] FIG. 2B shows a slot structure including the uplink DPDCH and DPCCH. In FIG. 2B, the number of TFCI, FBI, TPC and pilot bits can vary according to the service being provided (which changes the type of the traffic data), or because of transmit antenna diversity, or because of a handover circumstance. The FBI (FeedBack Information) is information that the mobile station requests about the antennas at the base station, when the base station uses the transmit diversity antennas. Tables 2 and 3 below show the symbols constituting the uplink DPDCH and DPCCH fields, respectively.

[Table 1]

Table 1												
Downlink DPDCH/DPDCH Fields												
Channel Channel Bit Rate (kbps)	Symbol Rate	SF	Bits/Frame			Bits/Slot	DPDCH Bits/Slot			DPCCH Bits/Slot		
			DPDCH	DPDCH	TOT		N _{data1}	N _{data2}	N _{TPC1}	N _{TPC2}	N _{TPC3}	N _{TPC4}
16	8	512	64	96	160	10	2	2	0	2	4	4
16	8	512	32	128	160	10	0	2	2	2	4	4
32	16	256	160	160	320	20	2	8	0	2	2	8
32	16	256	128	192	320	20	0	8	2	2	2	8
64	32	128	480	160	640	40	6	24	0	2	2	8
64	32	128	448	192	640	40	4	24	2	2	2	8
128	64	64	1120	160	1280	80	14	56	0	2	2	8
128	64	64	992	288	1280	80	6	56	8	2	2	8
256	128	32	2400	160	2560	160	30	120	0	2	2	8
256	128	32	2272	288	2560	160	22	120	8	2	2	8
512	256	16	4832	288	5120	320	62	240	0	2	2	16
512	256	16	4704	416	5120	320	54	240	8	2	2	16
1024	512	8	9852	288	10240	640	126	496	0	2	2	16
1024	512	8	9824	416	10240	640	118	496	8	2	2	16
2048	1024	4	20192	288	20480	1280	254	1008	0	2	2	16
2048	1024	4	20064	416	20480	1280	246	1008	8	2	2	16

[Table 2]

Uplink DPDCH Fields					
Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame	Bits/Slot	N _{data}
16	16	256	160	10	10
32	32	128	320	20	20
64	64	64	640	40	40
128	128	32	1280	80	80
256	256	16	2560	160	160
512	512	8	5120	320	320
1024	1024	4	10240	640	640

[Table 3]

Uplink DPCCH Fields								
Channel Bit Rate (kbps)	Channel Symbol Rate (ksps)	SF	Bits/Frame	Bits/Slot	N _{slot}	N _{TPC}	N _{TFCI}	N _{FB1}
16	16	256	160	10	6	2	2	0
16	16	256	160	10	8	2	0	0
16	16	256	160	10	5	2	2	1
16	16	256	160	10	7	2	0	1
16	16	256	160	10	6	2	0	2
16	16	256	160	10	5	1	2	2

[0013] Tables 1 to 3 show an example where there exists one DPDCH which is a traffic channel, wherein SF denotes spreading factor. However, there may exist second, third and fourth DPDCHs according to the service types. Further, the downlink and uplink both may include several DPDCHs.

[0014] An exemplary hardware structure of the conventional mobile communication system (base station transmitter and mobile station transmitter) will be described below with reference to FIGS. 3A and 3B. Although the base station transmitter and mobile station transmitter will be described with reference to a case where there exist three DPDCHs, the number of DPDCHs is not limited.

[0015] FIG. 3A shows a structure of the conventional base station transmitter. Referring to FIG. 3A, multipliers 111, 121, 131 and 132 multiply a DPDCH signal and DPDCH₁, DPDCH₂ and DPDCH₃ signals, which have undergone channel encoding and interleaving, by gain coefficients G₁, G₂, G₃ and G₄, respectively. The gain coefficients G₁, G₂, G₃ and G₄ may have different values according to circumstances such as the service option and the handover. A multiplexer (MUX) 112 time-multiplexes the DPCCH signal and the DPDCH₁ signal into the slot structure of FIG. 2A. A first serial-to-parallel (S/P) converter 113 distributes the output of the multiplexer 112 to an I channel and a Q channel. Second and third S/P converters 133 and 134 S/P-convert the DPDCH₂ and DPDCH₃ signals and distribute them to the I channel and the Q channel, respectively. The S/P-converted I and Q channel signals are multiplied by channelization codes C_{ch1}, C_{ch2} and C_{ch3} in multipliers 114, 122, 135, 136, 137 and 138, for spreading and channel separation. Orthogonal codes are used for the channelization codes.

[0016] The I and Q channel signals multiplied by the channelization codes in the multipliers 114, 122, 135, 136, 137 and 138 are summed by first and second summers 115 and 123, respectively. That is, the I channel signals are summed by the first summer 115, and the Q channel signals are summed by the second summer 123. The output of the second summer 123 is phase shifted by 90° by a phase shifter 124. A summer 116 sums an output of the first summer 115 and an output of the phase shifter 124 to generate a complex signal I+jQ. A multiplier 117 scrambles the complex signal with a PN sequence C_{scramb}, which is uniquely assigned to each base station, and a signal separator 118 separates the scrambled signal into a real part and an imaginary part and distributes them to the I channel and the Q channel. The I and Q channel outputs of the signal separator 118 are filtered by lowpass filters 119 and 125, respectively, to generate bandwidth-limited signals. The output signals of the filters 119 and 125 are multiplied by carriers cos(2 π f_ct) and sin(2 π f_ct), respectively, to generate the final transmitted signals.

and $\sin(2\pi f_c t)$ in multipliers 120 and 126, respectively, to frequency shift the signals to a radio frequency (RF) band. A summer 127 sums the frequency-shifted I and Q channel signals.

[0017] FIG. 3B shows a structure of the conventional mobile station transmitter. Referring to FIG. 3B, multipliers 211, 221, 223 and 225 multiply a DPCCCH signal and DPDCCH₁, DPDCCH₂ and DPDCCH₃ signals, which have undergone channel encoding and interleaving, by channelization codes (orthogonal codes) C_{ch1} , C_{ch2} , C_{ch3} and C_{ch4} , respectively, for spreading and channel separation. Orthogonal codes are used for the channelization codes. The output signals of the multipliers 211, 221, 223 and 225 are multiplied by gain coefficients G_1 , G_2 , G_3 and G_4 in multipliers 212, 222, 224 and 226, respectively. The gain coefficients G_1 , G_2 , G_3 and G_4 may have different values. The outputs of the multipliers 212 and 222 are summed by a first summer 213 and output as an I channel signal, and the outputs of the multipliers 224 and 226 are summed by a second summer 227 and output as a Q channel signal. The Q channel signal output from the second summer 227 is phase shifted by 90° in a phase shifter 228.

[0018] A summer 214 sums the output of the first summer 213 and the output of the phase shifter 228 to generate a complex signal $I+jQ$. A multiplier 215 scrambles the complex signal with a PN sequence C_{scramb} which is uniquely assigned to each station, and a signal separator 229 separates the scrambled signal into a real part and an imaginary part and distributes them to the I channel and the Q channel. The I and Q channel outputs of the signal separator 229 are filtered by lowpass filters 216 and 230, respectively, to generate bandwidth-limited signals. The output signals of the filters 216 and 230 are multiplied by carriers $\cos(2\pi f_c t)$ and $\sin(2\pi f_c t)$ in multipliers 217 and 231, respectively, to frequency shift the signals to a radio frequency (RF) band. A summer 218 sums the frequency-shifted I and Q channel signals.

[0019] A conventional transmission signal structure of the base station and the mobile station will be made below. FIG. 5A shows how to transmit the downlink DPCCCH and the uplink DPCCCH when transmission of the uplink DPCCCH is discontinued when there is no data to transmit for a predetermined time which is called control-only substate. FIG. 5B shows how to transmit the downlink DPCCCH and the uplink DPCCCH when transmission of the downlink DPCCCH is discontinued when there is no data to transmit. As illustrated in FIGS. 5A and 5B, the mobile station constantly transmits the uplink DPCCCH signal in spite of no DPDCCH data in order to avoid a resynchronization acquisition process between the base station and the mobile station. When there is no traffic data to transmit for a long time, the base station and the mobile station make a transition to an RRC (Radio Resource Control) connection release state (not shown in the FIGs.). In this state, transmission of the uplink DPCCCH is discontinued, but the mobile station transmits pilot symbols and power control bits over the DPCCCH until the transition is completed, thereby increasing interference in the uplink (or reverse link). The increase in interference of the uplink causes a decrease in the capacity of the uplink.

[0020] In the conventional method, although continuous transmission of the uplink DPCCCH in the control-only substate is advantageous in that it is possible to avoid the sync reacquisition process in the base station, it causes an interference to the uplink and mobile station power consumption, causing a decrease in the capacity of the uplink. Further, in the downlink, continuous transmission of the uplink power control bits causes an increase in interference for the sync reacquisition process in the base station, to minimize the interference due to transmission of the uplink DPCCCH and to minimize the interference and mobile station power consumption due to transmission of the uplink power control bits over the downlink.

40 SUMMARY OF THE INVENTION

[0021] It is, therefore, an object of the present invention to provide a communication device and method for minimizing the time required for a sync reacquisition process between base station and mobile station, for minimizing the interference and power consumption of mobile station due to transmission of a uplink DPCCCH, and for minimizing the interference due to transmission of uplink power control bits over a downlink when there is no data to transmit on DPDCCH for predetermined time.

[0022] It is another object of the present invention to provide a device and method for gating a dedicated control channel (DPCCCH) signal on a gated transmission unit basis in a mobile communication system, wherein the gated transmission unit is either identical to an actual slot unit or different from the actual slot unit.

[0023] It is further another object of the present invention to provide a device and method for locating a power control bit in the last slot of each frame to control the power of the first slot of the next frame in a mobile communication system.

[0024] To achieve the above object, a base station (or mobile station) according to the present invention determines whether there is data to transmit to the mobile station (or base station) on DPDCCH. When there is no data to transmit on DPDCCH, the base station (or mobile station) gates transmission of control information according to a predetermined time period pattern within one frame on a dedicated control channel. Here, "gated transmission" refers to transmitting time period pattern within one frame on a dedicated control channel (or PGs/slots) according to a predetermined time pattern. Control information included in the DPCCCH only at a specific power control group (PCG)/slot (or PGs/slots) according to a predetermined time pattern. Control information transmitted from the base station to the mobile station includes TFCI information about a format of transmission data, TPC information for power control, and a pilot symbol.

Control information transmitted from the mobile station to the base station includes TFCI information about a format of transmission data, TPC information for power control, a pilot symbol, and FBI information for requesting information about a phase difference between two antennas when the base station uses transmit diversity antenna. In a downlink transmitted in a frame during gated transmission. Alternatively, the pilot symbol in a predetermined nth power control group (or slot) and TFCI and TPC in (n+1)th power control group can be discontinuously transmitted in a frame. In an uplink DPCCCH, the TFCI, TPC, FBI and pilot symbol in a specific power control group (or slot) are discontinuously transmitted during gated transmission. If there is a short data to transmit on DPDCCH in gated transmission mode, the power control bit can be transmitted in all slot during transmit the short data. Further, a gating pattern for the downlink control information and a gating pattern for the uplink control information have an offset so that gating should occur at different time points.

BRIEF DESCRIPTION OF THE DRAWINGS

[0025] The above and other objects, features and advantages of the present invention will become more apparent from the following detailed description when taken in conjunction with the accompanying drawings in which:

FIG. 1A is a state transition diagram for a packet data service;
 FIG. 1B is a state transition diagram between a user data active substate and a control-only substate of the DCH/
 DCH state;
 FIG. 2A is a diagram illustrating a slot structure of downlink DPDCCH and DPCCCH;
 FIG. 2B is a diagram illustrating a slot structure of uplink DPDCCH and DPCCCH;
 FIG. 3A is a diagram illustrating a structure of a conventional base station transmitter;
 FIG. 3B is a diagram illustrating a structure of a conventional mobile station transmitter;
 FIG. 4A is a diagram illustrating a structure of a base station transmitter according to an embodiment of the present invention;
 FIG. 4B is a diagram illustrating a structure of a mobile station transmitter according to an embodiment of the present invention;
 FIG. 5A is a diagram for explaining how to transmit a downlink DPCCCH and a uplink DPCCCH when transmission of a uplink DPDCCH is discontinued in a conventional control-only substate;
 FIG. 5B is a diagram for explaining how to transmit a downlink DPCCCH and a uplink DPCCCH when transmission of a downlink DPDCCH is discontinued in the conventional control-only substate;
 FIG. 6A is a diagram illustrating a method for transmitting a signal according to a regular or gated transmission pattern for a uplink DPCCCH according to an embodiment of the invention;
 FIG. 6B is a diagram illustrating another method for transmitting a signal according to a regular or gated transmission pattern for a uplink DPCCCH according to an embodiment of the invention;
 FIG. 7A is a diagram illustrating a method for transmitting a signal when a uplink DPDCCH message is generated while a uplink DPCCCH is intermittently transmitted in a gating mode according to an embodiment of the invention;
 FIG. 7B is a diagram illustrating another method for transmitting a signal when a uplink DPDCCH message is generated while a uplink DPCCCH is intermittently transmitted in a gating mode according to an embodiment of the invention;
 FIG. 8A is a diagram illustrating a method for transmitting downlink and uplink signals when transmission of a downlink DPDCCH is discontinued according to an embodiment of the present invention;
 FIG. 8B is a diagram illustrating a method for transmitting downlink and uplink signals when transmission of a uplink DPDCCH is discontinued according to an embodiment of the present invention;
 FIG. 8C is a diagram illustrating another method for transmitting downlink and uplink signals when transmission of the downlink DPDCCH is discontinued according to an embodiment of the present invention;
 FIG. 8D is a diagram illustrating another method for transmitting downlink and uplink signals when transmission of the uplink DPDCCH is discontinued according to an embodiment of the present invention;
 FIG. 9A is a diagram illustrating a method for transmitting downlink and uplink signals when transmission of a downlink DPDCCH is discontinued (gated transmission for the downlink DPCCCH) according to an embodiment of the present invention;
 FIG. 9B is a diagram illustrating a method for transmitting downlink and uplink signals when transmission of a uplink DPDCCH is discontinued (gated transmission for downlink DPCCCH) according to an embodiment of the present invention;
 FIG. 10A is a diagram illustrating a structure of a base station transmitter according to another embodiment of the present invention;
 FIG. 10B is a diagram illustrating a structure of a mobile station transmitter according to another embodiment of

the present invention;
 FIG. 11A is a diagram illustrating gated transmission for downlink and uplink DPCCCHs according to a first embodiment of the present invention;
 FIG. 11B is a diagram illustrating gated transmission for downlink and uplink DPCCCHs according to a second embodiment of the present invention;
 FIG. 11C is a diagram illustrating gated transmission for downlink and uplink DPCCCHs according to a third embodiment of the present invention;
 FIG. 11D is a diagram illustrating gated transmission for downlink and uplink DPCCCHs according to a fourth embodiment of the present invention;
 FIG. 11E is a diagram illustrating gated transmission for downlink and uplink DPCCCHs according to a fifth embodiment of the present invention;
 FIG. 12A is a diagram illustrating gated transmission for downlink and uplink DPCCCHs according to a sixth embodiment of the present invention;
 FIG. 12B is a diagram illustrating gated transmission for downlink and uplink DPCCCHs according to a seventh embodiment of the present invention;
 FIG. 12C is a diagram illustrating gated transmission for downlink and uplink DPCCCHs according to an eighth embodiment of the present invention;
 FIG. 12D is a diagram illustrating gated transmission for downlink and uplink DPCCCHs according to a ninth embodiment of the present invention; and
 FIG. 12E is a diagram illustrating gated transmission for downlink and uplink DPCCCHs according to a tenth embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0026] Preferred embodiments of the present invention will be described herein below with reference to the accompanying drawings. In the following description, well-known functions or constructions are not described in detail since they would obscure the invention in unnecessary detail.

[0027] The term "normal transmission" as used herein refers to continuously transmitting control information included in the downlink or uplink DPCCCH, i.e., TFCI, TPC and pilot symbols. Further, the term "gate transmission" refers to a transmitting the control information included in the downlink DPCCCH, i.e., TFCI, TPC and pilot symbols, only at a specific power control group (or slot) according to a predetermined time pattern. In addition, the term "gate transmission" refers to transmitting the control information included in the uplink DPCCCH (i.e., TFCI, TPC and pilot symbols) only at a specific power control group (or one slot) according to a predetermined time pattern. The information, transmission of which is discontinued in the downlink DPCCCH during gated transmission, may include all of the TFCI, TPC and pilot symbols in a predetermined nth power control group (or slot), or may include the pilot symbols in a predetermined nth power control group (or slot), and TFCI and TPC in an (n+1)th power control group. The information, transmission of which is discontinued in the uplink DPCCCH during gated transmission, includes all of TFCI, TPC, FBI and pilot symbols in a specific power control group (or one slot). Herein, "a gated transmission unit is identical to a slot unit" means that TFCI, TPC and pilot symbols within one power control group are set as a gated transmission unit. Further, "a gated transmission unit is not identical to a slot unit" means that a pilot symbol in a predetermined nth slot and a TFCI and TPC in an (n+1)th slot are set as a gated transmission unit.

[0028] In addition, since performance at the beginning of a frame is very important, the invention locates the TPC for controlling the power of the first slot of the next frame at the last slot of one frame. That is, TPC bits for the downlink DPCCCH and the uplink DPCCCH are located at the last slot of the nth frame, and power of the first slot of the (n+1)th frame is controlled using the TPC bits existing at the last slot of the nth frame.

[0029] Further, a power control rate can be maintained normal transmission even when transmission data is generated during gated transmission of the DPCCCH signal according to the present invention. In addition, the gating pattern (or gated transmission pattern) for the downlink DPCCCH and the gating pattern for the uplink DPCCCH are determined to have an offset. That is, the control information for the downlink DPCCCH and the control information for the uplink DPCCCH are transmitted at different time points.

[0030] A hardware structure according to an embodiment of the invention will be described below.

[0031] FIG. 4A shows a structure of a base station transmitter according to an embodiment of the present invention. The base station transmitter is different from the conventional one of FIG. 3A in that with regard to the downlink DPCCCH, the output of the multiplier 111 is gated by a gated transmission controller 141. That is, the gated transmission controller 141 performs gated transmission on the TFCI and TPC bits for the downlink DPCCCH at a power control group (or time slot) scheduled with the mobile station when the traffic data is not transmitted over the downlink and uplink DPCCCHs for predetermined time. In addition, the gated transmission controller 141 performs gated transmission on one power control group (or one entire slot) including the pilot symbols, TFCI and TPC bits for the downlink DPCCCH at a power

control group (or time slot) scheduled with the mobile station when the traffic data is not transmitted over the downlink and uplink DPDCCHs for predetermined time.

[0032] Although the downlink gated transmission pattern is identical to the uplink gated transmission pattern, an offset may exist between them for efficient power control. The offset is given as a system parameter.

[0033] The gated transmission controller 141 can perform gated transmission either when the gated transmission unit is identical to the slot unit or when the gated transmission unit is not identical to the slot unit. When the gated transmission unit is not identical to the slot unit, the gated transmission controller 141 separately gates the TFCI, TPC and pilot symbols. That is, the pilot symbol in the predetermined nth slot, and the TFCI and TPC in the (n+1)th slot are set as a gated on transmission unit.

[0034] In addition, the gated transmission controller 141 locates the TPC bits for power controlling the first slot of the first slot of the (n+1)th frame is controlled using the TPC bits existing at the last slot of the nth frame. That is, the next frame at the last slot of one frame to guarantee performance of the beginning part of the next frame. That is, the TPC bits for the downlink DPDCCH and the uplink DPDCCH are located at the last slot of the nth frame, and power

of the first slot of the (n+1)th frame is controlled using the TPC bits existing at the last slot of the nth frame.

[0035] FIG. 4B shows a structure of a mobile station transmitter according to an embodiment of the present invention. The mobile station transmitter is different from the conventional one of FIG. 3B in that a gated transmission controller 241 is provided to gate transmission of the uplink DPDCCH. That is, the gated transmission controller 241 performs gated transmission on one power control group (or one entire slot) including the pilot symbols, TFCI, FBI and TPC bits for the uplink DPDCCH at a power control group (or time slot) scheduled with the mobile station in the control-only substate where the traffic data is not transmitted over the downlink and uplink DPDCCHs. For sync detection, it is necessary to transmit the pilot symbols and TPC bits over the uplink DPDCCH, and there is no alternative way to transmit the TPC, FBI and pilot symbols over the other uplink channels at the duration where transmission of the above channel is discontinued.

[0036] Now, a description will be made of a transmission signal structure of the base station and the mobile station according to an embodiment of the present invention.

[0037] FIG. 6A shows a method for transmitting a signal according to a regular or gated transmission pattern for the uplink DPDCCH in case of there is no DPDCCH data for a predetermined period of time according to an embodiment of the present invention. In FIG. 6A, reference numerals 301, 302, 303 and 304 show different gating rates according to a ratio of a duty cycle (hereinafter, referred to as DC). Reference numeral 301 shows a conventional method for transmitting the uplink DPDCCH without gating (DC=1, regular transmission), and reference numeral 302 shows a method for regularly transmitting every other power control group (or time slot), when DC=1/2 (only 1/2 of all the power control groups in one frame are transmitted). Reference numeral 303 shows a method for regularly transmitting every fourth power control group (3rd, 7th, 11th and 15th power control groups), when DC=1/4 (only 1/4 of all the power control groups in one frame are transmitted). Reference numeral 304 shows a method for regularly transmitting every eighth power control group (7th and 15th power control groups), when DC=1/8 (only 1/8 of all the power control groups in one frame are transmitted). In the embodiment of FIG. 6A, when DC=1/2 and 1/4, although the gated transmission controller 241 of the mobile station regularly gates the power control groups of the uplink DPDCCH, it is also possible to gate arbitrary power control groups out of all the standard power control groups according to the corresponding DC. That is, when DC=1/2, it is also possible to gate arbitrary power control groups according to an irregular pattern, rather than to regularly transmit every other power control group. Further, when DC=1/2, it is also possible to continuously transmit half of all the power control groups at the second half (8th to 15th power control groups) of the frame. When DC=1/4, it is also possible to continuously transmit 1/4 of all the power control groups beginning at a 3/4 point of the frame (i.e., 12th to 15th power control groups). When DC=1/8, it is also possible to continuously transmit 1/8 of all the power control groups beginning at a 7/8 point of the frame (i.e., 14th to 15th power control groups).

[0038] The above gating rate transition method can be divided into several methods as stated below, and is determined according to system setting. In one method, a direct gating rate transition occurs from DC=1/1 to DC=1/2, from DC=1/1 to DC=1/4, or from DC=1/1 to DC=1/8 according to a set timer value or a transition command message from the base station. In another method, a sequential gating rate transition occurs from DC=1/1 to DC=1/2, from DC=1/2 to DC=1/4, or from DC=1/4 to 1/8. Selection of the DC value can be determined in consideration of the capacity of the corresponding mobile station or the quality of the channel environment.

[0039] FIG. 6B shows a method for transmitting a signal according to a regular or gated transmission pattern for the uplink DPDCCH in case of there is no DPDCCH data for a predetermined period of time according to another embodiment of the present invention. In FIG. 6B, reference numerals 305, 306 and 307 show different gating rates according to a ratio of a duty cycle DC. Reference numeral 305 shows a method for transmitting two consecutive power control groups at regular locations (2nd-3rd, 6th-7th, 10th-11th and 14th-15th power control groups), when DC=1/2 (only 1/2 of all the power control groups in one frame are transmitted). Reference numeral 306 shows a method for transmitting two consecutive power control groups at regular locations (6th-7th and 14th-15th power control groups), when DC=1/4 (only 1/4 of all the power control groups in one frame are transmitted). Reference numeral 307 shows a method for transmitting two consecutive power control groups at regular locations (14th-15th power control groups), when DC=1/8 (only

1/8 of all the power control groups in one frame are transmitted). In the embodiment of FIG. 6B, when $DC=1/2$ and $1/4$, although the gated transmission controller 241 of the mobile station regularly gates the power control groups of the uplink DPCCCH, it is also possible to gate arbitrary power control groups out of all the power control groups according to the corresponding DC. That is, when $DC=1/2$, it is also possible to continuously gate 4 consecutive power control groups (e.g., 2nd-5th power control groups) according to an irregular pattern, rather than to regularly transmit every other 2 consecutive power control groups.

[0040] The above gating rate transition method can be divided into several methods as stated below, and is determined according to system setup. In one method, a direct state transition occurs from $DC=1/1$ (full rate) to $DC=1/2$, from $DC=1/1$ to $DC=1/4$, or from $DC=1/1$ to $DC=1/8$ according to a set timer value or a transition command message from the base station. In another method, a sequential gating rate transition occurs from $DC=1/1$ to $DC=1/2$, from $DC=1/2$ to $DC=1/4$, or from $DC=1/4$ to $1/8$. Selection of the DC value can be determined in consideration of the capacity of the corresponding mobile station or the quality of the channel environment.

[0041] FIGS. 7A and 7B show the uplink DPCCCH for the case where a transition message is transmitted over the uplink DPDCCH when a dedicated MAC (Medium Access Control) logical channel is generated in case of there is no DPDCCH data for a predetermined period of time of FIGS. 6A and 6B. Reference numeral 311 of FIG. 7A shows a case where a uplink DPDCCH message is generated while the uplink DPCCCH does not undergo gated transmission (i.e., where a uplink DPDCCH message is generated while the uplink DPCCCH does not undergo gated transmission (i.e., while the uplink DPCCCH is continuously transmitted ($DC=1/1$)). Reference numeral 312 shows a case where the uplink DPDCCH message is generated while the uplink DPCCCH undergoes $DC=1/2$ gated transmission. Reference numeral 313 shows a case where the uplink DPDCCH message is generated while the uplink DPCCCH undergoes $DC=1/4$ gated transmission. Reference numeral 314 shows a case where the uplink DPDCCH message is generated while the uplink DPCCCH undergoes $DC=1/8$ gated transmission.

[0042] The power control groups, as shown by the reference numerals 312, 313 and 314, are transmitted according to the gated transmission patterns in the first frame, and then undergo normal transmission when the uplink DPDCCH is transmitted in the second frame. In the power control groups for normal transmission, the TPC bits for downlink power control can be omitted and the pilot duration (or period) can be extended to a power control group length. Beginning at the power control groups succeeding after transmitting the uplink DPCCCH without gating, or it is possible to gate transmission of the uplink DPCCCH according to the original DC value until a gating rate transition message is received from the base station. That is, when the uplink DPDCCH message is transmitted for $DC=1/2$ gated transmission, it is possible to perform normal transmission on the power control group of the above duration, thereafter perform $DC=1/2$ gated transmission again, and then perform $DC=1$ (regular transmission) gated transmission when the DPDCCH user data exist.

[0043] Like the uplink DPCCCH, even in the downlink, when a downlink DPDCCH message is generated during gated transmission for the DPCCCH, the power control groups, which are transmitted according to the gated transmission pattern, undergo normal transmission for transmit the downlink DPDCCH. In the power control groups for normal transmission, the TPC bits for downlink power control can be omitted and the pilot duration can be extended to a power control group length. Beginning at the power control groups succeeding after transmitting the downlink DPDCCH message by normal transmission of the power control groups, it is possible to transmit the downlink DPCCCH without gating, or it is possible to gate transmission of the downlink DPCCCH according to the original DC value until a state transition or request message is received from the mobile station. That is, when the downlink DPDCCH message is transmitted for $DC=1/2$ gated transmission, it is possible to perform normal transmission on the power control group of the above duration, thereafter perform $DC=1/2$ gated transmission again, and then perform $DC=1$ gated transmission when transmitting the DPDCCH user data.

[0044] Reference numeral 315 of FIG. 7B shows a case where a uplink DPDCCH message is generated while the uplink DPCCCH undergoes $DC=1/2$ gated transmission. Reference numeral 316 shows a case where the uplink DPDCCH message is generated while the uplink DPCCCH undergoes $DC=1/4$ gated transmission. Reference numeral 317 shows a case where the uplink DPDCCH message is generated while the uplink DPCCCH undergoes $DC=1/8$ gated transmission. The power control groups, as shown by the reference numerals 315, 316 and 317, are transmitted according to the gated transmission patterns, and then undergo normal transmission for transmit the downlink DPDCCH message. In the power control groups for normal transmission, the TPC bits for downlink power control can be omitted and the pilot duration (or period) can be extended to a power control group length. Beginning at the power control groups succeeding after transmitting the uplink DPDCCH message by normal transmission of the power control groups, it is possible to transmit the uplink DPCCCH without gating, or it is possible to gate transmission of the uplink DPCCCH according to the original DC value until a state transition message is received from the base station. That is, when the uplink DPDCCH message is transmitted for $DC=1/2$ gated transmission, it is possible to perform normal transmission on the power control group of the above duration, thereafter perform $DC=1/2$ gated transmission again, and then perform $DC=1$ gated transmission when transmitting the DPDCCH user data.

[0045] It is also possible to simultaneously gate transmission of both the uplink DPCCCH and the downlink DPCCCH

according to the same gating pattern. Beginning at the power control groups succeeding after transmitting the downlink DPDCH message by normal transmission of the power control groups, generated while gating transmission of the downlink DPDCH, it is possible to transmit the downlink DPDCH without gating, or it is possible to gate transmission of the downlink DPDCH according to the original DC value until a state transition request message is received from the mobile station. That is, when the downlink DPDCH message is transmitted for DC=1/2 gated transmission, it is possible to perform normal transmission on the power control group of the above duration, thereafter perform DC=1/2 gated transmission again, and then perform DC=1 gated transmission when transmitting the DPDCH user data.

[0046] FIG. 8A shows a method for transmitting downlink and uplink signals when transmission of a downlink DPDCH is discontinued. When transmission of the downlink DPDCH is discontinued as shown by reference numeral 801 in the user data active substate where there exists no uplink DPDCH, the base station and the mobile station start gating transmission if a set timer value expires or a downlink DPDCH message for state transition is generated. Although FIG. 8A shows an embodiment where the message for start gating transmission is generated by the base station, it is also possible for the mobile station to send a gating-request message to the base station when there is no downlink and uplink DPDCH. While transmitting the downlink DPDCH in FIG. 8A, it is also possible to transmit all the TFCI, TPC and pilot symbols without gating. Since the TPC bits include meaningless TPC values determined by measuring power strength of the pilot symbols of the gated power control groups within the uplink DPDCH, the mobile station ignores the meaningless TPC values transmitted from the base station in order to perform uplink power control in consideration of the gating pattern for the uplink DPDCH, and performs transmission at the same transmission power as the transmission power for the previous power control group. Alternatively, while transmitting the downlink DPDCH in FIG. 8A, it is also possible to gate only the TFCI and TPC bits in the downlink DPDCH without gating the pilot symbols in the downlink DPDCH. At this point, the gating pattern is identical to a gating pattern for the uplink DPDCH of the mobile station. The power control group, in which the TPC bits in the downlink DPDCH are gated, refers to the TPC bits generated by measuring the pilot symbols corresponding to the gated power control group in the DPDCH transmitted from the mobile station.

[0047] Reference numeral 802 shows a situation where a message for gated transmission is generated by the base station and is transmitted to the mobile station over the downlink DPDCH. In this case, the mobile station, which has been gating transmission of the uplink DPDCH, can stop gated transmission upon receipt of the message for stop the gated transmission and perform normal transmission (DC=1) when uplink DPDCH data should be transmitted. Alternatively, the mobile station, which has been gating transmission of the uplink DPDCH, can continue gated transmission even after receipt of the message for stop the gated transmission, stop gated transmission at the stop time included in the gated transmission stop message, and then perform normal transmission (DC=1).

[0048] FIG. 8B shows a method for transmitting downlink and uplink signals when transmission of a uplink DPDCH is discontinued. When transmission of the uplink DPDCH is discontinued as shown by reference numeral 803 in the user data active substate where there exists no downlink DPDCH, the base station and the mobile station make the gating transmission at a time point appointed (or scheduled) between them when a set timer value expires or after exchanging a gated transmission message. Although FIG. 8B shows an embodiment where the message for gated transmission is generated in the downlink DPDCH, the gated transmission message can also be generated in the uplink DPDCH of the mobile station. While transmitting the downlink DPDCH in FIG. 8B, it is also possible to transmit all the DPDCH of the mobile station. Since the TPC bits include meaningless TPC values determined by measuring power strength of the pilot symbols of the gated power control groups within the uplink DPDCH, the mobile station ignores the meaningless TPC values transmitted from the base station in order to perform uplink power control in consideration of the gating pattern for the uplink DPDCH, and performs transmission at the same transmission power as the transmission power for the previous power control group. Alternatively, while transmitting the downlink DPDCH in FIG. 8B, it is also possible to gate only the TFCI and TPC bits in the downlink DPDCH without gating the pilot symbols in the downlink DPDCH. At this point, the gating pattern is identical to a gating pattern for the uplink DPDCH of the mobile station. The power control group, in which the TPC bits in the downlink DPDCH are gated, refers to the TPC bits generated by measuring the pilot symbols corresponding to the gated power control group in the DPDCH transmitted from the mobile station.

[0049] Reference numeral 804 shows a situation where a gated transmission message generated by the base station is transmitted to the mobile station over the downlink DPDCH. In this case, the mobile station, which has been gating transmission of the uplink DPDCH, can stop gated transmission upon receipt of the message for stop gated transmission and perform normal transmission (DC=1). Alternatively, the mobile station, which has been gating transmission of the uplink DPDCH, can continue gated transmission even after receipt of the message for stop gated transmission, stop gated transmission at the stop time included in the gated transmission stop message, and then perform normal transmission (DC=1).

[0050] FIG. 8C shows a method for transmitting downlink and uplink signals when transmission of a downlink DPDCH is discontinued. When transmission of the downlink DPDCH is discontinued as shown by reference numeral 805 in the user data active substate where there exists no uplink DPDCH, the base station and the mobile station start gated

transmission if a set timer value expires or a downlink DPDCCH message for start gated transmission is transmitted. Although FIG. 8C shows an embodiment where the message for gated transmission request is generated by the base station, it is also possible for the mobile station to send a gated transmission request message to the base station when there is no downlink and uplink DPDCCH. While transmitting the downlink DPDCCH in FIG. 8C, it is also possible to transmit all the TFCI, TPC and pilot symbols without gating. Since the TPC bits include meaningless TPC values determined by measuring the power strength of the pilot symbols of the gated power control groups within the uplink DPDCCH, the mobile station ignores the meaningless TPC values transmitted from the base station in order to perform uplink power control in consideration of the gating pattern for the uplink DPDCCH, and performs transmission at the same transmission power as the transmission power for the previous power control group. Alternatively, while transmitting the downlink DPDCCH in FIG. 8C, it is also possible to gate only the TFCI and TPC bits in the downlink DPDCCH without gating the pilot symbols in the downlink DPDCCH. At this point, the gating pattern is identical to a gating pattern for the uplink DPDCCH of the mobile station. The power control group, in which the TPC bits in the downlink DPDCCH are gated, refers to the TPC bits generated by measuring the pilot symbols corresponding to the gated power control group in the DPDCCH transmitted from the mobile station.

[0051] Reference numeral 806 shows a situation where a gated transmission message is generated by the mobile station in the DPCCCH transmitted from the mobile station. In this case, the mobile station, which has been gating and is transmitted to the base station over the uplink DPDCCH. In this case, the mobile station, which has been gating transmission of the uplink DPCCCH, can stop gated transmission after transmission of the gated transmission message over the uplink DPDCCH and then perform normal transmission (DC=1). Alternatively, the mobile station, which has been gating transmission of the uplink DPCCCH, can continue gated transmission even after receiving gated transmission stop message, stop gated transmission at the stop time included in the gated transmission stop message, and then perform normal transmission (DC=1).

then perform normal transmission (DC=1). FIG. 8D shows a method for transmitting downlink and uplink signals when transmission of a uplink DPDCCH [0052] is discontinued. When transmission of the uplink DPDCCH is discontinued as shown by reference numeral 807 in the user data active subframe where there exists no downlink DPDCCH for a predetermined period of time, the base station and the mobile station can start gated transmission at a time point appointed (or scheduled) between them when a set timer value expires or after exchanging a gated transmission message. Although FIG. 8D shows an embodiment where the message for gated transmission is generated in the downlink DPDCCH, the gated transmission message can also be generated in the uplink DPDCCH of the mobile station. While transmitting the downlink DPDCCH in FIG. 8D, it is also possible to transmit all the TFCI, TPC and pilot symbols without gating. Since the TPC bits include meaningless TPC values determined by measuring power strength of the pilot symbols of the gated power control groups within the uplink DPDCCH, the mobile station ignores the meaningless TPC values transmitted from the base station in order to perform DPDCCH, the mobile station ignores the gating pattern for the uplink DPDCCH, and performs transmission at the uplink power control as the transmission power for the previous power control group. Alternatively, while transmitting the downlink DPDCCH in FIG. 8D, it is also possible to gate only the TFCI and TPC bits in the downlink DPDCCH without gating the pilot symbols in the downlink DPDCCH. At this point, the gating pattern is identical to a gating pattern for the uplink DPDCCH of the mobile station. The power control group, in which the TPC bits in the downlink DPDCCH are gated, refers to the TPC bits generated by measuring the pilot symbols corresponding to the gated power control group in the DPDCCH transmitted from the mobile station.

group in the DPCH transmitted from the mobile station.

[0053] Reference numeral 808 shows a situation where a gated transmission message generated by the mobile station is transmitted to the base station over the uplink DPCH. In this case, the mobile station, which has been gating transmission of the uplink DPCH, can stop gated transmission after transmission of the gated transmission message over the uplink DPCH and then perform normal transmission (DC=1). Alternatively, the mobile station, which has been gating transmission of the uplink DPCH, can continue gated transmission even after transmission of the gated transmission stop message, stop gated transmission at the stop time included in the gated transmission stop message, and then perform normal transmission (DC=1).

and then perform normal transmission (DC=1).
[0054] FIG. 9A shows a method for transmitting downlink and uplink signals when transmission of a downlink DPDCCH is discontinued. When transmission of the downlink DPDCCH is discontinued, the base station and the mobile station can start gated transmission at a time point appointed between them if a set timer value expires or after exchanging a gated transmission message. FIG. 9A shows a case where a gating pattern for the downlink DPDCCH 501 is identical to a gating pattern for the uplink DPDCCH 503. Although FIG. 9A shows an embodiment where the gated transmission message is generated through the downlink DPDCCH, the gated transmission message can also be generated through the uplink DPDCCH of the mobile station.

the uplink DPDCCH of the mobile station.

[0055] FIG. 9B shows a method for transmitting downlink and uplink signals when transmission of a uplink DPDCCH is discontinued. When transmission of the uplink DPDCCH is discontinued, the base station and the mobile station make a state transition at a time point appointed between them if a set timer value expires or after exchanging a state transition message. FIG. 9B shows a case where a gating pattern for the downlink DPDCCH is identical to a gating pattern for the uplink DPDCCH. Although FIG. 9B shows an embodiment where the state transition message is generated through the downlink DPDCCH, the state transition message can also be generated through the uplink DPDCCH of the mobile station.

[0056] In the foregoing drawings and descriptions, the downlink and uplink frames have the same frame starting point. However, in the UTRA system, the starting point of the uplink frame is artificially delayed by 250 μ sec as compared with the starting point of the downlink frame. This is to make power control time delay become one slot (=0.625ms) in consideration of the propagation delay of the transmission signal when the cell radius is below 30km. Therefore, with due consideration of the artificial time delay between the downlink and uplink frame start time, the methods for transmitting the DPCCCH signal according to gated transmission are shown by FIGS. 11A to 11E. FIGS. 10A and 10B show structures of the base station controller and the mobile station controller, respectively, which enable such gated transmission.

[0057] FIG. 10A shows a structure of the base station controller according to another embodiment of the present invention. The base station transmitter is different from FIG. 4A in that the pilot, TFCI and TPC bits constituting the downlink DPCCCH can be separately gated according to different gating patterns by the gated transmission controller 141. That is, the gated transmission controller 141 performs gated transmission on the pilot, TFCI and TPC bits for the downlink DPCCCH at a power control group (or time slot) scheduled with the mobile station in the control-only substate where the traffic data is not transmitted over the downlink and uplink DPDCCHs. By using the gated transmission controller 141, it is also possible to assemble a pilot of a n th slot and TFCI and TPC bits of a $(n+1)$ th slot into a gated transmission unit. When the base station transmits signaling data using the gated transmission controller 141 during gated transmission in the control-only substate, it is possible to avoid performing gated transmission on the pilot and TFCI at the duration where the signaling data is transmitted.

[0058] Alternatively, the gated transmission controller 141 can perform gated transmission on one power control group (or one entire slot) including the pilot symbols, TFCI and TPC bits for the downlink DPCCCH at a power control group (or time slot) scheduled with the mobile station in the control-only substate when the traffic data is not transmitted over the downlink and uplink DPDCCHs.

[0059] Although the downlink gated transmission pattern is identical to the uplink gated transmission pattern, there can exist an offset therebetween for efficient power control. The offset is given as a system parameter.

[0060] FIG. 10B shows a structure of the mobile station transmitter according to another embodiment of the present invention. The mobile station transmitter is different from FIG. 4B in that the pilot, TFCI, FBI and TPC bits constituting the uplink DPCCCH can be separately gated according to different patterns by the gated transmission controller 241. The gated transmission controller 241 gates transmission of the pilot, TFCI, FBI and TPC bits for the uplink DPCCCH at a power control group (or time slot) scheduled with the mobile station in the control-only substate when the traffic data is not transmitted over the downlink and uplink DPDCCHs. When the base station transmits signaling data using the gated transmission controller 241 during gated transmission in the control-only substate, it is possible to avoid performing gated transmission on the pilot and TFCI at the duration when the signaling data is transmitted.

[0061] Alternatively, the gated transmission controller 241 can perform gated transmission on one power control group (or one entire slot) including the pilot symbols, TFCI, FBI and TPC bits for the uplink DPCCCH at a power control group (or time slot) scheduled with the mobile station in the control-only substate when the traffic data is not transmitted over the downlink and uplink DPDCCHs.

[0062] Although the downlink gated transmission pattern is identical to the uplink gated transmission pattern, there can exist an offset therebetween for efficient power control. The offset is given as a system parameter.

[0063] FIGS. 11A to 11E and FIGS. 12A to 12E show signal transmission diagrams for gated transmission performed by the base station and the mobile station transmitters of FIGS. 10A and 10B. FIGS. 11A to 11E show how to perform gated transmission when the frame length is 10msec and each frame includes 16 power control groups, i.e., each power control group has a length of 0.625msec. FIGS. 12A to 12E show how to perform gated transmission when the frame length is 10msec and each frame includes 15 power control groups, i.e., each power control group has a length of 0.667msec.

[0064] FIG. 11A shows gated transmission for the downlink and uplink DPCCCHs according to a first embodiment of the present invention. As shown in FIG. 11A, a gated transmission unit for the downlink DPCCCH may not be a slot unit. That is, with regard to two adjacent slots, a pilot symbol of an predetermined n th slot and TFCI and TPC bits of an $(n+1)$ th slot are set as a gated transmission unit for the downlink DPCCCH because of the pilot symbol is used for channel estimation to detect the TFCI and TPC. For example, when the gating rate is $1/2$, a pilot symbol of slot number 0 and TFCI and TPC bits of slot number 1 are set as a gated transmission unit for the downlink DPCCCH. When the gating rate is $1/4$, a pilot symbol of slot number 2 and TFCI and TPC bits of slot number 3 are set as a gated transmission unit for the downlink DPCCCH. When the gating rate is $1/8$, a pilot symbol of slot number 6 and TFCI and TPC bits of slot number 7 are set as a gated transmission unit for the downlink DPCCCH. Here, the gated transmission unit for the downlink DPCCCH is set to be different from the actual slot unit, since an n th pilot symbol may be required in the receiver to demodulate the $(n+1)$ th TPC according to a demodulation method for the TPC signal.

[0065] When a signaling message is generated during such gated transmission, the signaling message is transmitted over the downlink or uplink DPDCCH. Therefore, performance of the frame starting point is very important. In the invention, as shown in FIG. 11A, the TPC for the downlink DPCCCH and the TPC for the uplink DPCCCH are located at slot

number 15 (i.e., the 16th slot, which is the last slot of the nth frame), so that the first slot of the (n+1)th frame is power controlled using the TPC bits existing in the last slot of an nth frame. That is, the TPC for power controlling the first slot of the next frame is located at the last slot of the present frame.

[0066] Meanwhile, in the UTRA system stated above, an offset between the downlink and uplink frame start points is fixed to 250 μ sec. However, in gated transmission of the downlink and uplink DPCCs, the offset value can be changed to an arbitrary value while the base station and the mobile station exchange a parameter for DPCC gated transmission in the call setup process. The offset value is set to a proper value in consideration of propagation delay of the base station and the mobile station in the call setup process. That is, when the cell radius is over 30Km, the offset value can be set to a value larger than the conventional offset value of 250 μ sec for DPCC gated transmission, and this value can be determined through experiments.

[0067] FIG. 11B shows gated transmission for the downlink and uplink DPCCs according to a second embodiment of the present invention. FIG. 11B shows a case where transmission of the downlink DPCC goes ahead of transmission of the uplink DPCC during gated transmission, for the gating rates of 1/2, 1/4 and 1/8. The difference (i.e., offset) is designated by "DL-UL timing" for the gating rates of 1/2, 1/4 and 1/8.

[0068] Referring to FIG. 11B, with regard to two adjacent slots, a pilot symbol of the predetermined-nth slot and TFCI and TPC of the (n+1)th slot are set as a gated transmission unit for the downlink DPCC. For example, for the gating rate 1/2, a pilot symbol of slot number 0 and TFCI and TPC of slot number 1 are set as a gated transmission unit for the downlink DPCC. For the gating rate 1/4, a pilot symbol of slot number 2 and TFCI and TPC of slot number 3 are set as a gated transmission unit for the downlink DPCC. For the gating rate 1/8, a pilot symbol of slot number 6 and TFCI and TPC of slot number 7 are set as a gated transmission unit for the downlink DPCC.

[0069] In addition, it is noted that the TPC for power controlling the first slot of the next frame is located at the last slot of the present frame. That is, the TPC for the downlink DPCC and the TPC for the uplink DPCC are both located at slot number 15 (i.e., the 16th slot).

[0070] FIG. 11C shows gated transmission for the downlink and uplink DPCCs according to a third embodiment of the present invention. FIG. 11C shows a case where transmission of the uplink DPCC goes ahead of transmission of the downlink DPCC during gated transmission, for the gating rates of 1/2, 1/4 and 1/8.

[0071] Referring to FIG. 11C, with regard to two adjacent slots, a pilot symbol of the predetermined nth slot and TFCI and TPC of the (n+1)th slot are set as a gated transmission unit for the downlink DPCC. For example, for the gating rate 1/2, a pilot symbol of slot number 1 and TFCI and TPC of slot number 2 are set as a gated transmission unit for the downlink DPCC. For the gating rate 1/4, a pilot symbol of slot number 2 and TFCI and TPC of slot number 3 are set as a gated transmission unit for the downlink DPCC. For the gating rate 1/8, a pilot symbol of slot number 6 and TFCI and TPC of slot number 7 are set as a gated transmission unit for the downlink DPCC.

[0072] In addition, it is noted that the TPC for power controlling the first slot of the next frame is located at the last slot of the present frame. That is, the TPC for the downlink DPCC and the TPC for the uplink DPCC are both located at slot number 15 (i.e., the 16th slot).

[0073] FIG. 11D shows gated transmission for the downlink and uplink DPCCs according to a fourth embodiment of the present invention. FIG. 11D shows a case where for the gating rates of 1/2, 1/4 and 1/8, transmission of the downlink DPCC goes ahead of transmission of the uplink DPCC during gated transmission, and the downlink and uplink gating patterns are set to the same period.

[0074] Referring to FIG. 11D, with regard to two adjacent slots, a pilot symbol of the predetermined nth slot and TFCI and TPC of the (n+1)th slot are set as a gated transmission unit for the downlink DPCC. For example, for the gating rate 1/2, a pilot symbol of slot number 0 and TFCI and TPC of slot number 1 are set as a gated transmission unit for the downlink DPCC. For the gating rate 1/4, a pilot symbol of slot number 2 and TFCI and TPC of slot number 3 are set as a gated transmission unit for the downlink DPCC. For the gating rate 1/8, a pilot symbol of slot number 6 and TFCI and TPC of slot number 7 are set as a gated transmission unit for the downlink DPCC.

[0075] In addition, it is noted that the TPC for power controlling the first slot of the next frame is located at the last slot of the present frame. That is, the TPC for the downlink DPCC and the TPC for the uplink DPCC are both located at slot number 15 (i.e., the 16th slot).

[0076] FIG. 11E shows gated transmission for the downlink and uplink DPCCs according to a fifth embodiment of the present invention. FIG. 11E shows a case where for the gating rates of 1/2, 1/4 and 1/8, transmission of the uplink DPCC goes ahead of transmission of the downlink DPCC during gated transmission, and the downlink and uplink gating patterns are set to the same period.

[0077] Referring to FIG. 11E, with regard to two adjacent slots, a pilot symbol of the nth slot and TFCI and TPC of the (n+1)th slot are set as a gated transmission unit for the downlink DPCC. For example, for the gating rate 1/2, a pilot symbol of slot number 1 and TFCI and TPC of slot number 2 are set as a gated transmission unit for the downlink DPCC. For the gating rate 1/4, a pilot symbol of slot number 2 and TFCI and TPC of slot number 3 are set as a gated transmission unit for the downlink DPCC. For the gating rate 1/8, a pilot symbol of slot number 6 and TFCI and TPC of slot number 7 are set as a gated transmission unit for the downlink DPCC.

[0076] In addition, it is noted that the TPC for power controlling the first slot of the next frame is located at the last slot of the present frame. That is, the TPC for the downlink DPCCCH and the TPC for the uplink DPCCCH are both located at a slot number 15 (i.e., the 16th slot).

[0079] FIG. 12A shows gated transmission for the downlink and uplink DPCCCHs according to a sixth embodiment of the present invention. FIG. 12A shows a case where a gating rate for gated transmission of the downlink and uplink DPCCCHs is 1/3, i.e., gated transmission is performed at the periods corresponding to 1/3 power control groups of the DPCCCHs is 1/3, i.e., gated transmission is performed at the periods corresponding to 5 power control whole power control groups. That is, gated transmission is performed at the periods corresponding to 5 power control groups out of the whole 15 power control groups. At this point, a gated transmission unit for the downlink DPCCCH is set to be different from a slot unit. That is, with regard to two adjacent slots, a pilot symbol of the predetermined nth slot and TFCI and TPC of the (n+1)th slot are set as a gated transmission unit for the downlink DPCCCH because of the pilot symbol is used for channel estimation to detect the TFCI and the TPC.

[0080] In FIG. 12A, <Case 1> shows a case where the uplink DPCCCH and the downlink DPCCCH are transmitted at the same time during gated transmission, and the downlink and uplink gating patterns are set to the same period. With regard to two adjacent slots, a pilot symbol of slot number 1 and TFCI and TPC of slot number 2 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 4 and TFCI and TPC of slot number 5 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 7 and TFCI and TPC of slot number 8 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 10 and TFCI and TPC of slot number 11 are set as a gated transmission unit for the downlink DPCCCH; and a pilot symbol of slot number 13 and TFCI and TPC of slot number 14 are set as a gated transmission unit for the downlink DPCCCH.

[0081] <Case 2> shows a case where transmission of the uplink DPCCCH occurs before transmission of the downlink DPCCCH during gated transmission. At this point, with regard to two adjacent slots, a pilot symbol of slot number 0 and TFCI and TPC of slot number 1 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 3 and TFCI and TPC of slot number 4 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 6 and TFCI and TPC of slot number 7 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 9 and TFCI and TPC of slot number 10 are set as a gated transmission unit for the downlink DPCCCH; and a pilot symbol of slot number 12 and TFCI and TPC of slot number 13 are set as a gated transmission unit for the downlink DPCCCH.

[0082] <Case 3> shows a case where transmission of the uplink DPCCCH occurs before transmission of the downlink DPCCCH during gated transmission. At this point, with regard to two adjacent slots, a pilot symbol of slot number 1 and TFCI and TPC of slot number 2 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 4 and TFCI and TPC of slot number 5 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 7 and TFCI and TPC of slot number 8 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 10 and TFCI and TPC of slot number 11 are set as a gated transmission unit for the downlink DPCCCH; and a pilot symbol of slot number 13 and TFCI and TPC of slot number 14 are set as a gated transmission unit for the downlink DPCCCH.

[0083] <Case 4> shows a case where transmission of the uplink DPCCCH occurs after transmission of the downlink DPCCCH during gated transmission. At this point, with regard to two adjacent slots, a pilot symbol of slot number 14 DPCCCH and TFCI and TPC of slot number 0 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 2 and TFCI and TPC of slot number 3 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 5 and TFCI and TPC of slot number 6 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 8 and TFCI and TPC of slot number 9 are set as a gated transmission unit for the downlink DPCCCH; and a pilot symbol of slot number 11 and TFCI and TPC of slot number 12 are set as a gated transmission unit for the downlink DPCCCH.

[0084] <Case 5> shows a case where transmission of the uplink DPCCCH occurs after transmission of the downlink DPCCCH during gated transmission. At this point, with regard to two adjacent slots, a pilot symbol of slot number 0 and TFCI and TPC of slot number 1 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 3 and TFCI and TPC of slot number 4 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 6 and TFCI and TPC of slot number 7 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 9 and TFCI and TPC of slot number 10 are set as a gated transmission unit for the downlink DPCCCH; and a pilot symbol of slot number 12 and TFCI and TPC of a slot number 13 are set as a gated transmission unit for the downlink DPCCCH.

[0085] FIG. 12B shows gated transmission for the downlink and uplink DPCCCHs according to a seventh embodiment of the present invention. FIG. 12A shows a case where the gating rate for gated transmission of the downlink and uplink DPCCCHs is 1/5, i.e., gated transmission is performed so that 1/5 of the power control groups are transmitted in uplink DPCCCHs is 1/5, i.e., gated transmission is performed so that 1/5 of the power control groups are transmitted in uplink DPCCCHs is 1/5, i.e., gated transmission is performed so that 3 power control groups out of the standard 15 power control groups are transmitted. At this point, a gated transmission unit for the downlink DPCCCH is set to be different from a slot unit. That is, with regard to two adjacent slots, a pilot symbol of the predetermined nth slot and TFCI and TPC of the (n+1)th slot are set as a gated transmission unit for the

downlink DPCCCH because of the pilot symbol is used for channel estimation to detect the TFCI and the TPC.

[0086] Referring to FIG. 12B, with regard to two adjacent slots, a pilot symbol of slot number 3 and TFCI and TPC of slot number 4 are set as a gated transmission unit for the downlink DPCCCH; a pilot symbol of slot number 8 and TFCI and TPC of slot number 9 are set as a gated transmission unit for the downlink DPCCCH; and a pilot symbol of slot number 13 and TFCI and TPC of slot number 14 are set as a gated transmission unit for the downlink DPCCCH.

[0087] FIG. 12C shows gated transmission for the downlink and uplink DPCCCHs according to an eighth embodiment of the present invention. Referring to FIG. 12C, the gating pattern is set such that the last power control group of the uplink DPCCCH should not be gated in the control-only substate. Such a gating pattern has high channel estimation performance, since the base station can perform channel estimation using the pilot symbols in the last power control group of the frame. In addition, it is possible to increase the time required when the base station processes the FBI

bits transmitted from the mobile station.

[0088] FIG. 12D shows gated transmission for the downlink and uplink DPCCCHs according to a ninth embodiment of the present invention. Shown is a gating pattern for transmitting a downlink message during gated transmission in the control-only substate.

[0089] Referring to FIG. 12D, for the frame period where the downlink message is transmitted (i.e., DPDCCH transmission period), gated transmission is discontinued for the pilot and TFCI, and only the TPC continues to undergo gated transmission according to the gating pattern. For the period where the downlink data (message) is not transmitted, the pilot symbols and TFCI as well as TPC undergo gated transmission. The pilot symbol is transmitted at the 0th, 3rd, 6th, 9th and 12th slots only, and the TFCI and TPC bits are transmitted at the 1st, 4th, 7th, 10th and 13th slots only. When the downlink data is transmitted during such gated transmission, the pilot symbol and TFCI are transmitted at every slot, whereas TPC is transmitted at the 1st, 4th, 7th, 10th and 13th slots only. Accordingly, even though downlink transmission data is generated during gated transmission, the power control rate is maintained.

[0090] FIG. 12E shows gated transmission for the downlink and uplink DPCCCHs according to a tenth embodiment of the present invention. Shown is a gating pattern for transmitting an uplink message during gated transmission in the control-only substate. For a period where the uplink data (message) is not transmitted, the pilot symbols and TFCI as well as TPC and FBI undergo gated transmission. The pilot symbol, TFCI, FBI and TPC are transmitted at 2nd, 5th, 8th, 11th and 14th slots only. When the uplink data is transmitted during such gated transmission, the pilot symbol and TFCI are transmitted at every slot, whereas TPC and FBI are transmitted at the 2nd, 5th, 8th, 11th and 14th slots only. Accordingly, even though uplink transmission data is generated during gated transmission, the power control rate is maintained.

[0091] As shown in FIGS. 12D and 12E, for the DPDCCH transmission period where the uplink message is transmitted, several embodiments of the invention discontinue gated transmission of the pilot and TFCI and continue to transmit FBI and TPC according to the gating rate.

[0092] As described above, the invention minimizes the time required for the sync reacquisition process in the base station, minimizes interference as well as uplink DPCCCH transmission time, and minimizes interference due to the transmission of the uplink power control bit over the downlink, all of which increases the capacity of the mobile communication system.

[0093] While the invention has been shown and described with reference to certain preferred embodiments thereof, it will be understood by those skilled in the art that various changes in form and details may be made therein without departing from the spirit and scope of the invention as defined by the appended claims.

[0094] The following is a list of further preferred embodiments of the invention:

Embodiment 1. A method for transmitting down link DPCCCH signals in a base station for a mobile communication system, comprising the steps of:

determining whether the base station has down link DPDCCH data to transmit to a mobile station; and

gating transmission of the down link DPCCCH signal according to a predetermined pattern when there is no data to transmit for predetermined period of time.

Embodiment 2. The method as claimed in embodiment 1, wherein the the DPCCCH signal is transmitted in slot format, said slot having power control bit which control the up link transmission power, and the predetermined pattern is a pattern for gating transmission of the DPCCCH slot signal during gated transmission of DPCCCH signal.

Embodiment 3. The method as claimed in embodiment 1, wherein the DPCCCH signal includes power control bit.

Embodiment 4. The method as claimed in embodiment 2, wherein the DPCCCH signal includes a pilot symbol, a format of transmission data frame, and power control bit for up link transmission power control.

Embodiment 5. The method as claimed in embodiment 4, wherein the slot format includes pilot symbols, TFCI bits and power control bit, and predetermined pattern is a pattern for gating transmission of the pilot symbol, the TFCI bits and the power control bit at predetermined n slots out of total slots of frame.

Embodiment 6. The method as claimed in embodiment 4, wherein the slot format includes pilot symbols, TFCI bits and power control bit, and predetermined pattern is a pattern for gating transmission of the pilot symbol at an predetermined n th slot and the TFCI bits and power control bit at a $(n+1)$ th slot.

Embodiment 7. The method as claimed in embodiment 2, wherein the power control bit gating transmission is maintained regular when the base station transmit DPDCH data to the mobile station.

Embodiment 8. A base station transmission device for a mobile communication system, comprising:

a multiplexer for multiplexing a first channel signal and a second channel signal into a frame which is segmented into a plurality of slots, and for outputting the frame;

a switch for gating the first channel signal; and

a controller for gating the switch such that the first channel signal undergoes gated transmission within a frame according to a predetermined pattern when there is no second channel signal to be transmitted to a mobile station.

Embodiment 9. The base station transmission device as claimed in embodiment 8, wherein the predetermined pattern is a pattern for gating transmission of the first channel signal at predetermined slots.

Embodiment 10. The base station transmission device as claimed in embodiment 8, wherein the first channel signal includes power control bit.

Embodiment 11. The base station transmission device as claimed in embodiment 9, wherein the first channel signal includes a pilot symbol, TFCI bits, and power control bit.

Embodiment 12. The base station transmission device as claimed in embodiment 11, wherein the predetermined pattern is a pattern for gating transmission of the pilot symbol, the TFCI bits and the power control bit at an predetermined n slot out of total slots of frame.

Embodiment 13. The base station transmission device as claimed in embodiment 11, wherein the predetermined pattern is a pattern for gating transmission of the pilot symbol at an predetermined n th slot and the TFCI bits and the power control bit at a $(n+1)$ th slot.

Embodiment 14. The base station transmission device as claimed in embodiment 10, wherein the controller maintains regular transmission for the power control bit when the base station transmit DPDCH data to the mobile station during gated transmission.

Embodiment 15. The base station transmission device as claimed in embodiment 8, wherein the first channel is a DPDCH.

Embodiment 16. The base station transmission device as claimed in embodiment 8, wherein the second channel is a DPDCH.

Embodiment 17. A method for transmitting control DPCH signal in a mobile station of a mobile communication system, comprising the steps of:

determining whether the mobile station has data to transmit to a base station; and

gating transmission of the DPCH signal according to a predetermined pattern for maintain link power control loop when there is no data to transmit for predetermined period of time.

Embodiment 18. The method as claimed in embodiment 17, wherein the DPCH signal have frame format, said

frame includes a plurality of slots, and the predetermined pattern is a pattern for gating transmission of the DPCCH signal.

Embodiment 19. The method as claimed in embodiment 17, wherein the DPCCH signal includes at least power control bit.

Embodiment 20. The method as claimed in embodiment 18, wherein the DPCCH signal includes a pilot symbol, TFCI bits, and FBI bits for at least one phase difference between at least two antennas when the base station uses transmit diversity antennas.

Embodiment 21. The method as claimed in embodiment 20, wherein the predetermined pattern is a pattern for gating transmission of the pilot symbol, the TFCI bits, the power control bit, and FBI bits at predetermined slots.

Embodiment 22. The method as claimed in embodiment 19, wherein the up link DPCCH signal is transmitted continuously during mobile station transmit DPDCH data to the base station.

Embodiment 23. The method as claimed in embodiment 22, wherein the transmission power of the DPDCH data is increased than regular transmission.

Embodiment 24. A mobile station transmission device for a mobile communication system, comprising:

a Dedicated Physical Control Channel (DPCCH) for transmitting pilot symbol, TFCI bits for indicating frame format of Dedicated Physical Data Channel (DPDCH) frame, FBI bits for feed back information of diversity antenna signal, and power control bit for control down link transmission power;

a Dedicated Physical Data Channel (DPDCH) for transmitting user data or signaling data to base station with the Dedicated Physical Control Channel (DPCCH);

a switch for gating the Dedicated Physical Control Channel (DPCCH) signal; and

a controller for gating the switch such that the Dedicated Physical Control Channel (DPCCH) signal undergoes gated transmission within the frame according to a predetermined pattern when there is no Dedicated Physical Data Channel (DPDCH) signal to be transmitted to the base station for predetermined period of time.

Embodiment 25. The mobile station transmission device as claimed in embodiment 24, wherein the predetermined pattern is a pattern for gating transmission of the Dedicated Physical Control Channel (DPCCH) signal at predetermined slots.

Embodiment 26. The mobile station transmission device as claimed in embodiment 24, wherein the Dedicated Physical Control Channel (DPCCH) signal includes power control information.

Embodiment 27. The mobile station transmission device as claimed in embodiment 25, wherein the Dedicated Physical Control Channel (DPCCH) and the Dedicated Physical Data Channel (DPDCH) is spread with orthogonal code respectively for channel separation and the channel signals are multiplied with gain value respectively.

Embodiment 28. The mobile station transmission device as claimed in embodiment 27, wherein the time period pattern is a pattern for gating transmission of the pilot symbol, the TFCI bits, the FBI bits and the power control bit at an predetermined nth slot out of total slots of a frame.

Embodiment 29. The mobile station transmission device as claimed in embodiment 26, wherein the controller control the DPCCH signal with regularly when the mobile station transmit DPDCH data.

Embodiment 30. A method for transmitting control information in a mobile communication system, comprising the steps of:

(a) determining whether a base station has data to transmit to a mobile station;

(b) transmitting gating message to indicate gating start time and gating pattern to a mobile station when the

data to transmit has not exist predetermined period of time;

(c) gating transmission of first control information according to gating pattern on a downlink dedicated control channel, said downlink dedicated control channel for transmitting the first control information to the mobile station;

(d) determining whether the mobile station has data to transmit to the base station; transmitting gating request message to the base station when the data to transmit has not exist predetermined period of time;

(e) gating, when the mobile station has received the gating message and reach the gating start time from the base station, transmission of second control information according to a predetermined second pattern within one frame on an uplink dedicated control channel, said uplink dedicated control channel for transmitting the second control information to the base station.

Embodiment 31. The method as claimed in embodiment 30, wherein the frame on the downlink dedicated control channel is segmented into a plurality of slots and the predetermined first pattern is a pattern for gating transmission of the first control information at predetermined slots.

Embodiment 32. The method as claimed in embodiment 30, wherein the first control information includes power control information.

Embodiment 33. The method as claimed in embodiment 31, wherein the first control information includes a pilot symbol, first information about a format of transmission data, and second information for power control.

Embodiment 34. The method as claimed in embodiment 33, wherein the predetermined first pattern is a pattern for gating transmission of the pilot symbol, the first information and the second information at an predetermined nth slot.

Embodiment 35. The method as claimed in embodiment 33, wherein the predetermined first pattern is a pattern for gating transmission of the pilot symbol at an predetermined nth slot and the first information and the second information at a (n+1)th slot.

Embodiment 36. The method as claimed in embodiment 31, wherein gated transmission for the power control information is maintained when the base station generates data to be transmitted to the mobile station during gated transmission of the first control information.

Embodiment 37. The method as claimed in embodiment 30, wherein the frame on the uplink dedicated control channel is segmented into a plurality of slots and the predetermined second pattern is a pattern for gating transmission of the second control information at predetermined slots.

Embodiment 38. The method as claimed in embodiment 37, wherein the second control information includes power control information.

Embodiment 39. The method as claimed in embodiment 37, wherein the second control information includes a pilot symbol, first information about a format of the transmission data, and second information for requesting information about at least one phase difference between at least two antennas when the base station uses transmit diversity antennas, and third information for power control.

Embodiment 40. The method as claimed in embodiment 37, wherein the predetermined second pattern is a pattern for gating transmission of the pilot symbol, the first information, the second information and the third information at predetermined slots.

Embodiment 41. The method as claimed in embodiment 38, wherein gated transmission for the power control information is maintained when the mobile station has data to transmit to the base station during gated transmission of the second control information.

Embodiment 42. The method as claimed in embodiment 39, wherein gated transmission for the second information and the third information is maintained when the mobile station has data to transmit to the base station during

gated transmission of the second control information.

Embodiment 43. The method as claimed in embodiment 30, wherein there is a time offset between the predetermined first pattern and the predetermined second pattern.

Claims

1. A method for transmitting down link signals from a base station to a mobile station of a mobile communication system in which base stations operate asynchronously compared to other base stations, the down link signal including a data transmission channel signal and a control channel signal, the control channel signal having control data related to connection or release of the data transmission channel and a physical control signal corresponding to the data transmission channel when there is down link data to transmit, the method performed in the base station comprising the steps of:
 - determining whether the base station has down link data to transmit to the mobile station on the data transmission channel; and
 - gating transmission of the physical control signal according to a predetermined gated on or off pattern when there is no data to transmit on the data transmission channel for a predetermined period of time.
2. The method as claimed in claim 1, wherein the physical control signal is transmitted in a gated on slot format, said slot having a power control bit which controls the up link transmission power.
3. The method as claimed in claim 1, wherein the physical control signal includes a power control bit.
4. The method as claimed in claim 2, wherein the physical control signal includes a pilot symbol, a format of transmission data frame, and the power control bit for up link transmission power control.
5. The method as claimed in claim 4, wherein the slot format includes pilot symbols, TFCI (Transport Format Combination Indicator) bits and the power control bit, and the predetermined pattern is a pattern for gating transmission of the pilot symbol, the TFCI bits and the power control bit at predetermined n slots out of total slots of a frame.
6. The method as claimed in claim 4, wherein the slot format includes pilot symbols, TFCI bits and the power control bit, and the predetermined gated on or off pattern is a pattern for gating transmission of the pilot symbol at a predetermined n th slot and the TFCI bits and the power control bit at a $(n+1)$ th slot.
7. The method as claimed in claim 2, wherein the gated transmission of the power control bit is maintained regular when the base station transmits the data channel signal to the mobile station on the data transmission channel.

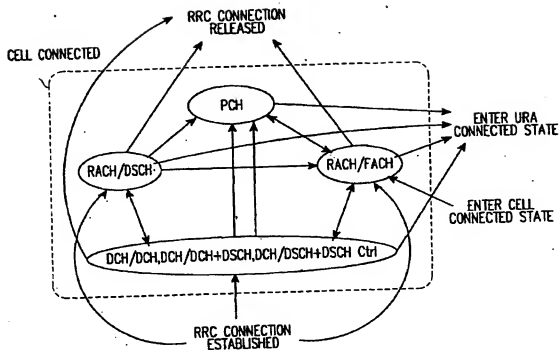


FIG. 1A

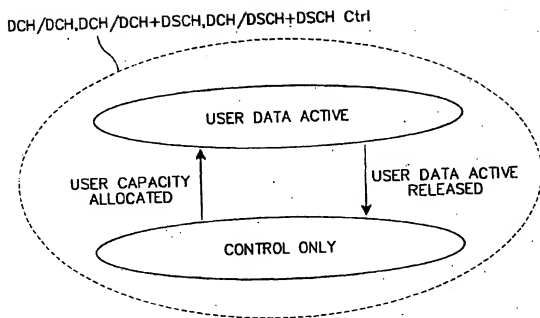


FIG. 1B

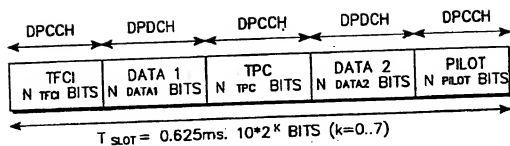


FIG. 2A

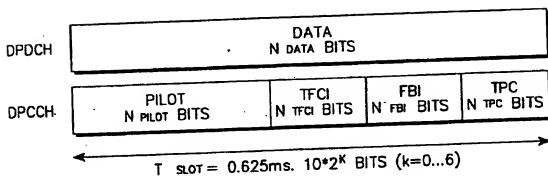


FIG. 2B

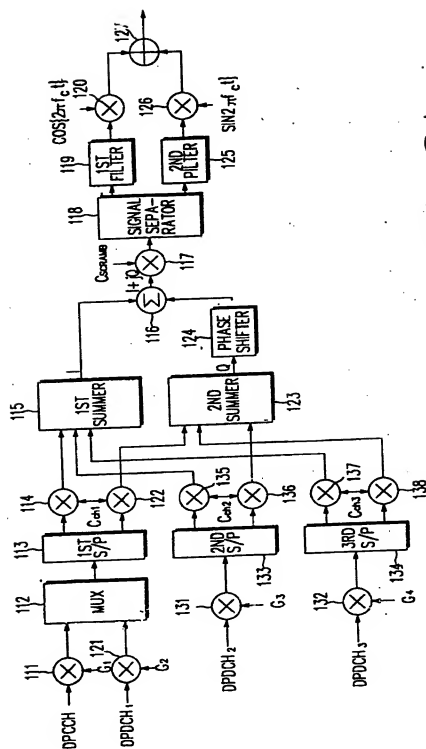


FIG. 3A

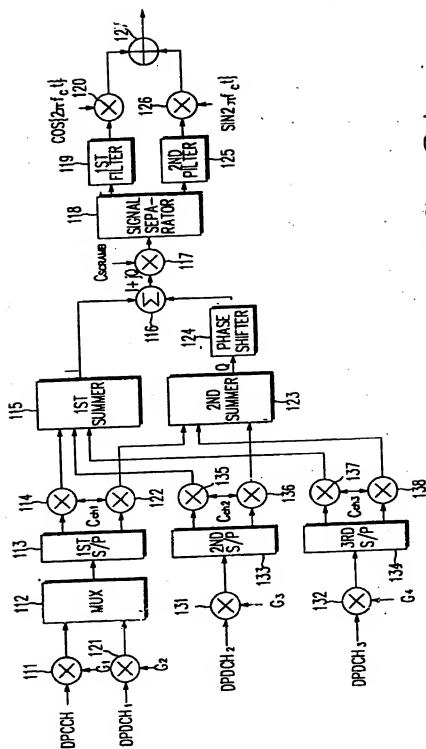


FIG. 3A

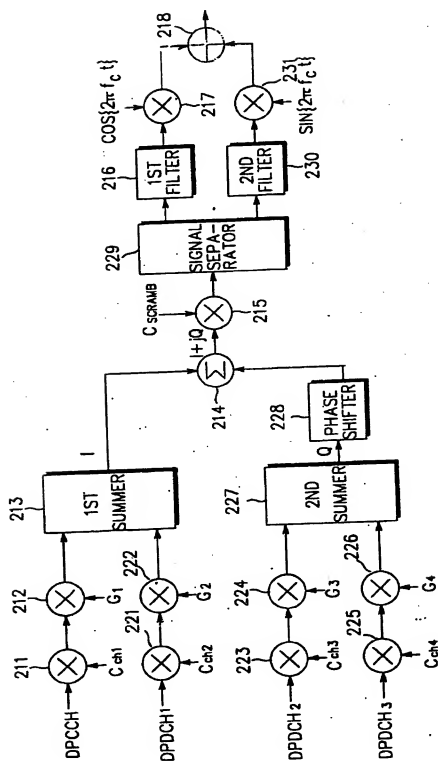


FIG. 3B

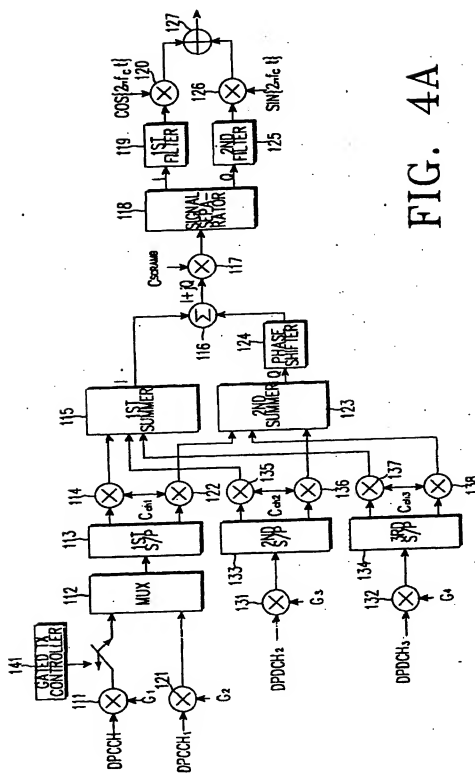


FIG. 4A

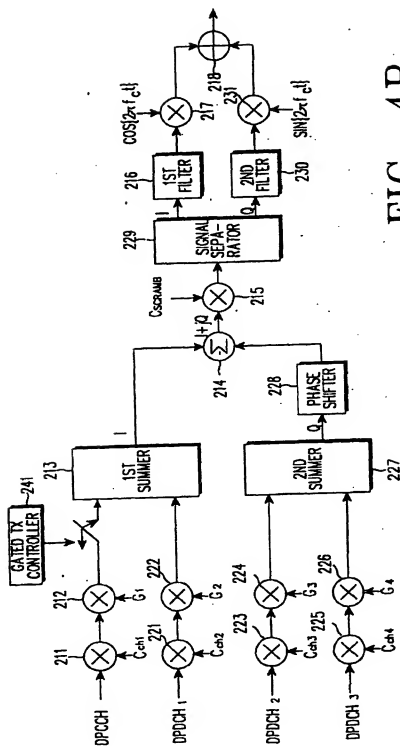


FIG. 4B

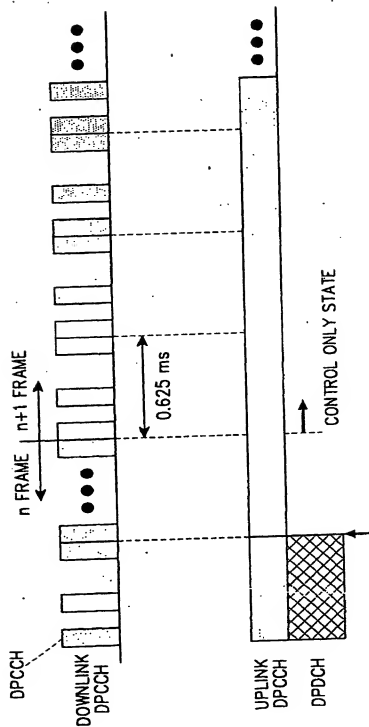


FIG. 5A

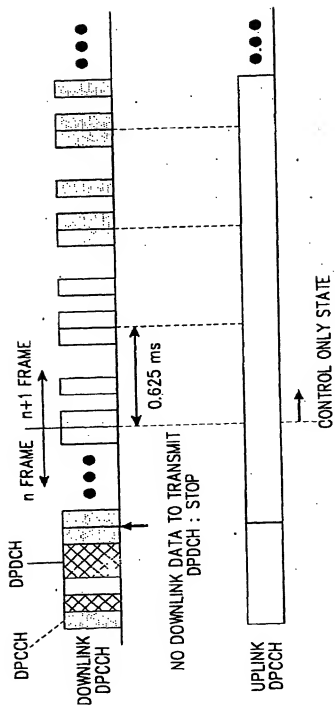


FIG. 5B

FIG. 6A

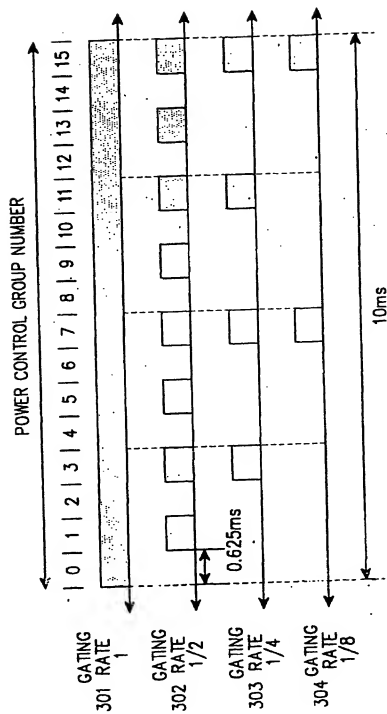


FIG. 6B

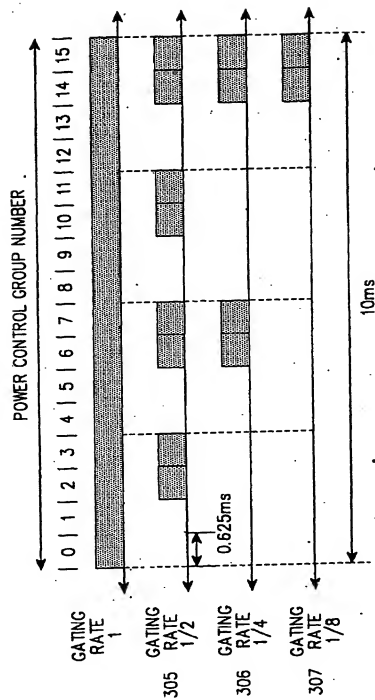


FIG. 7A

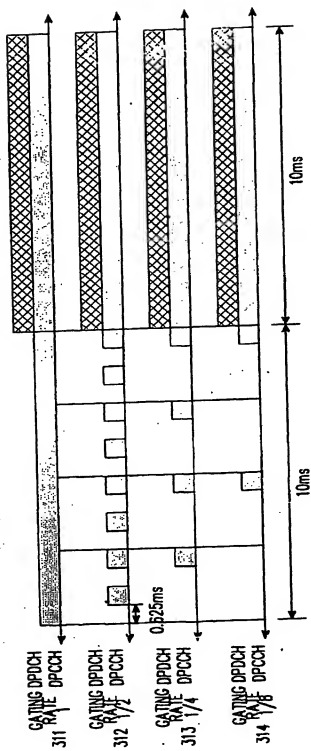


FIG. 7B

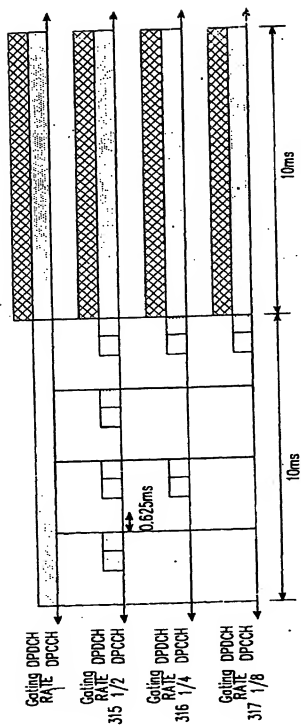
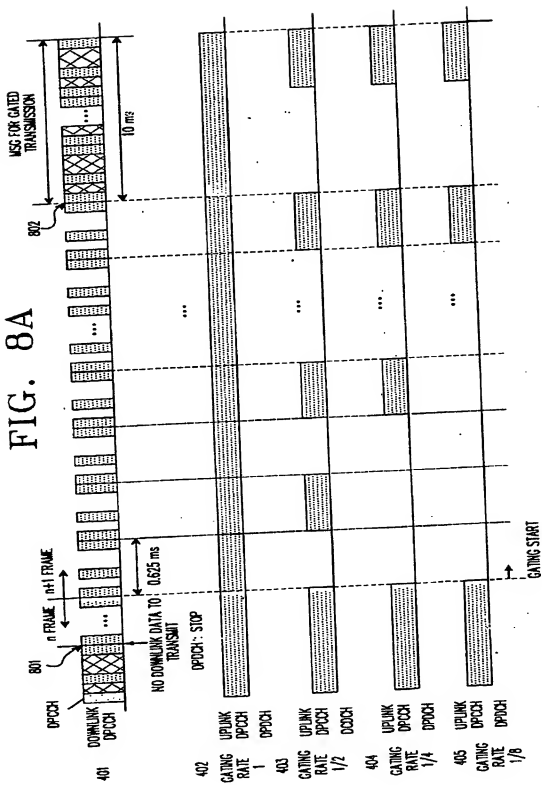


FIG. 8A



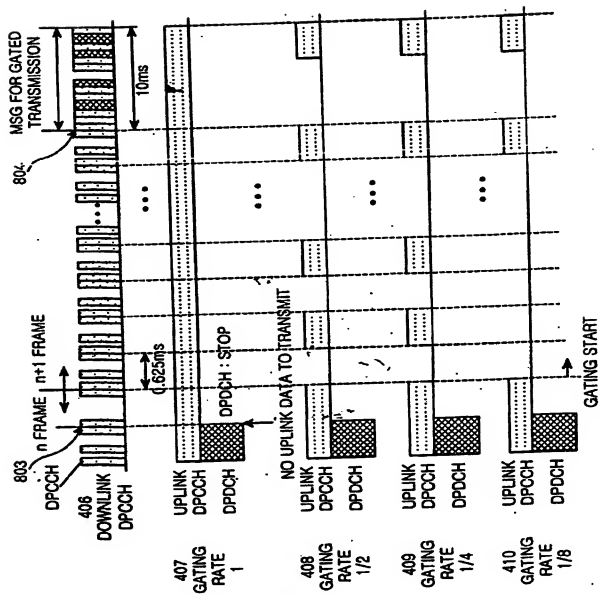


FIG. 8B

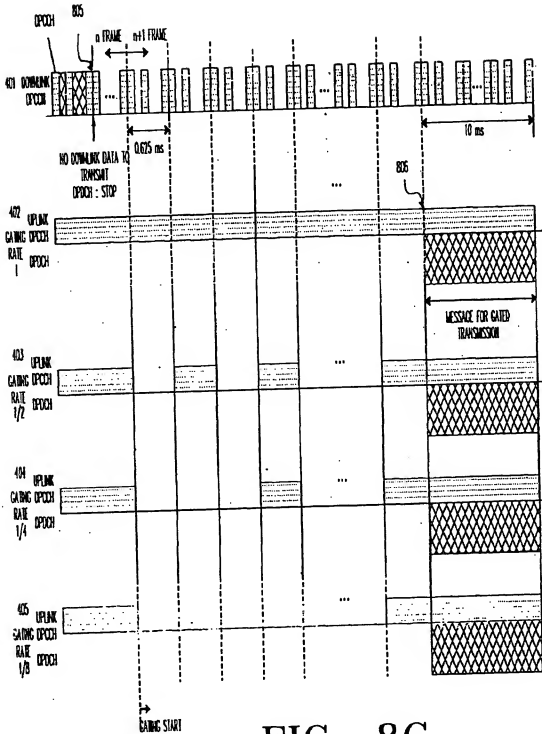


FIG. 8C

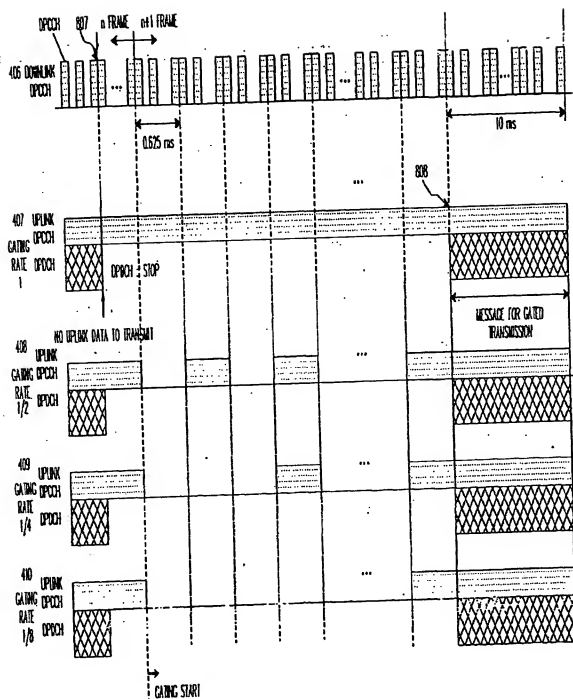


FIG. 8D

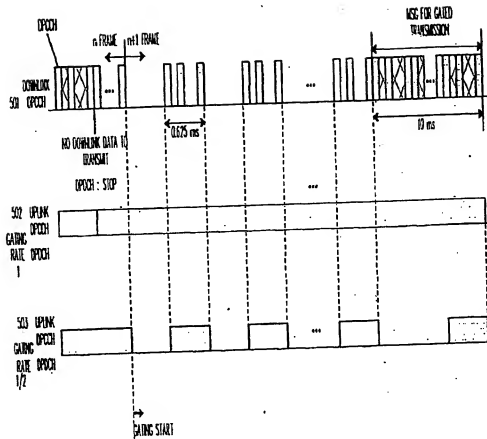


FIG. 9A

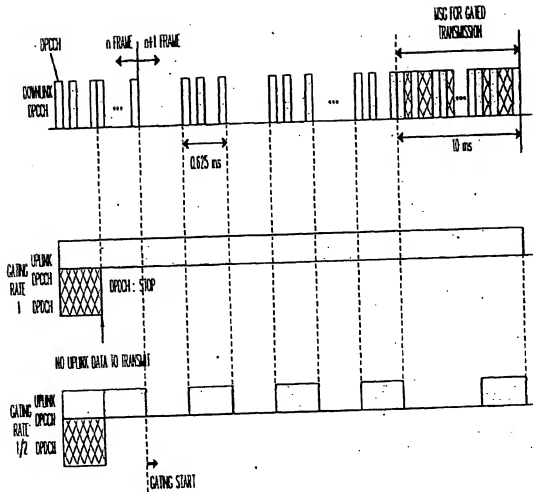
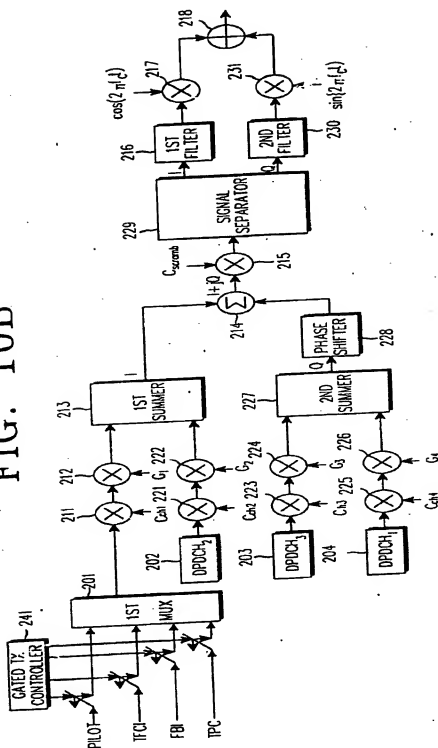


FIG. 9B

FIG. 10B



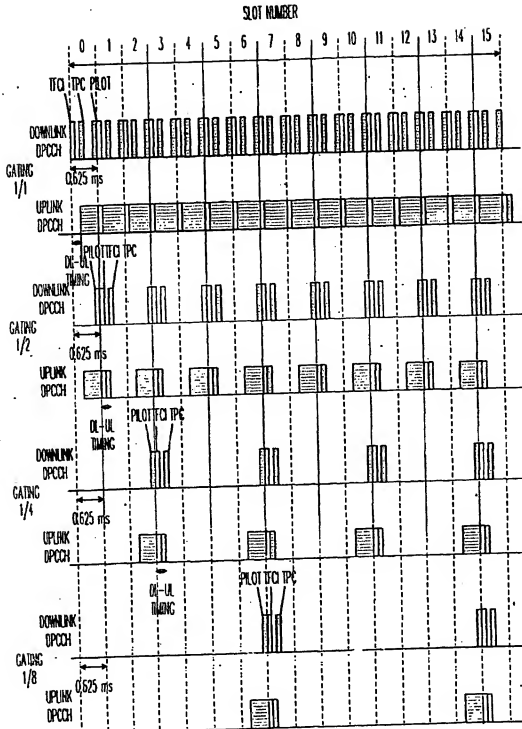


FIG. 11A

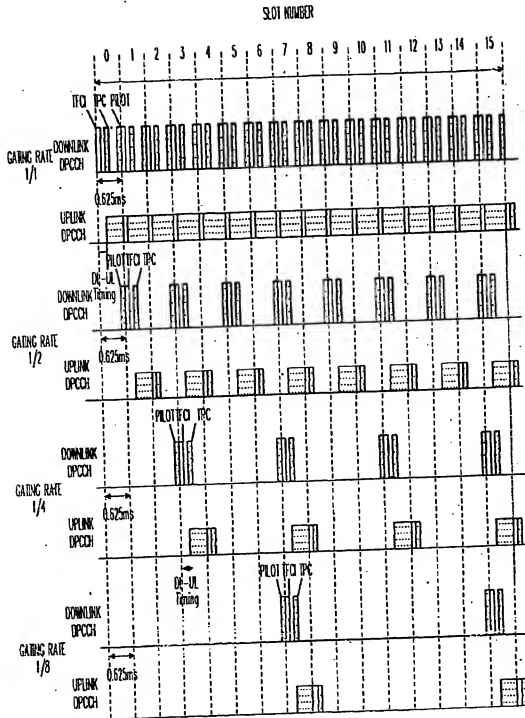


FIG. 11B

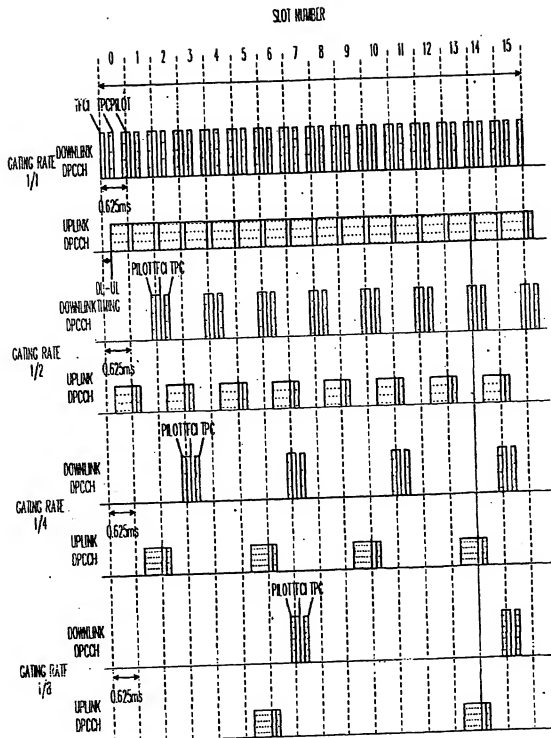


FIG. 11C

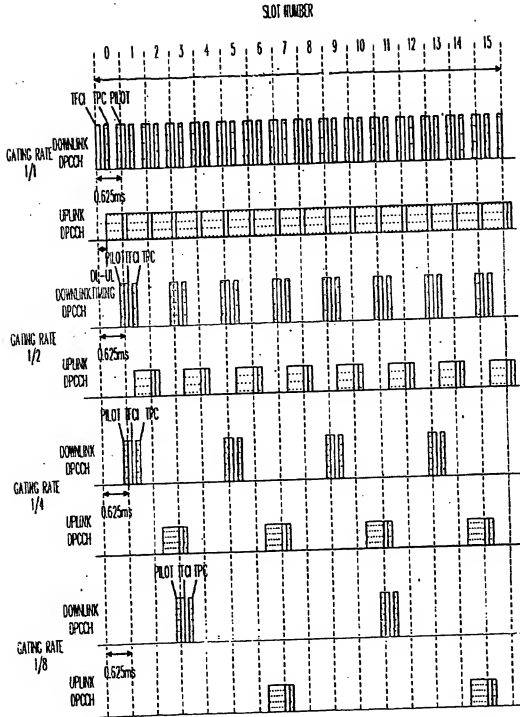


FIG. 11D

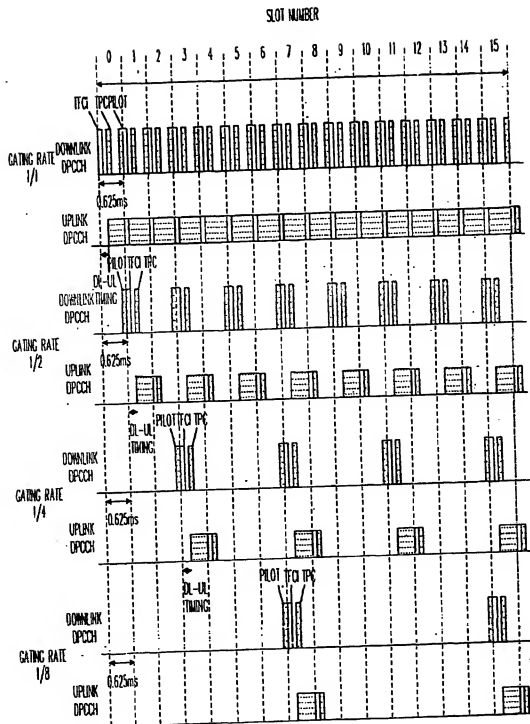


FIG. 11E

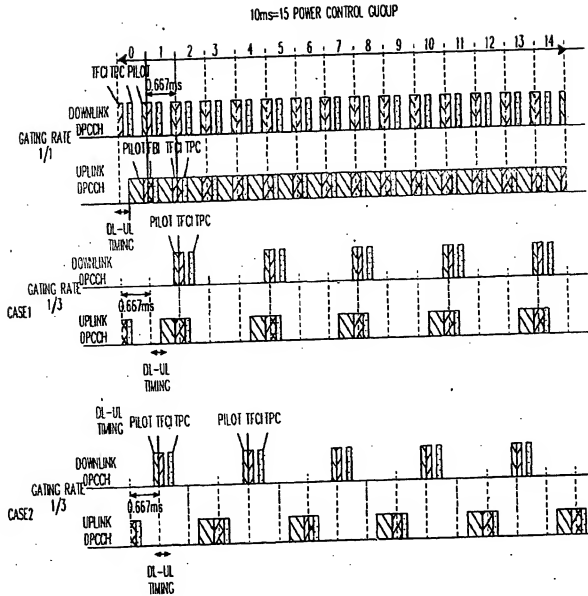


FIG. 12A

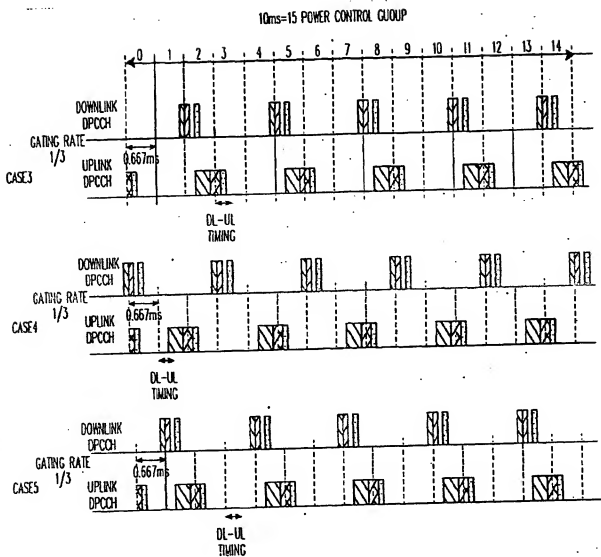


FIG. 12A

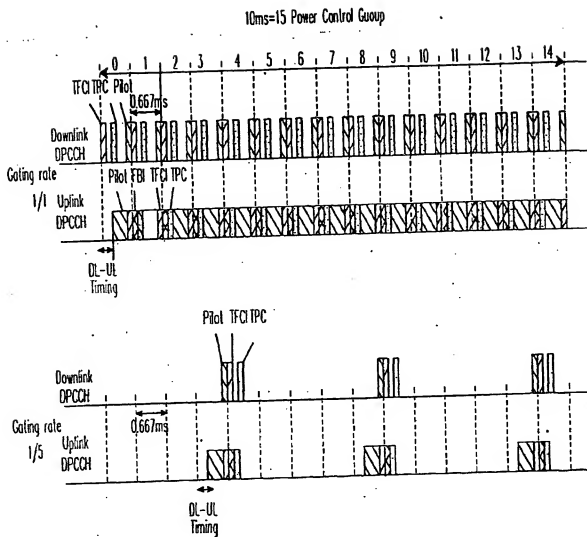


FIG. 12B

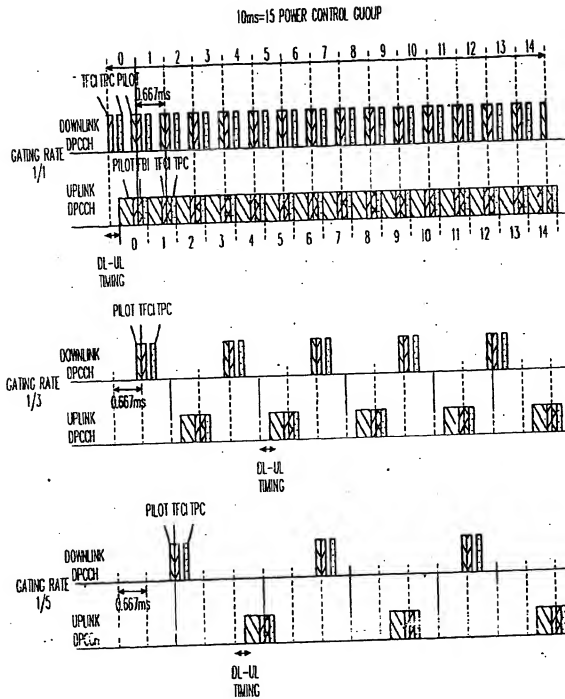


FIG. 12C

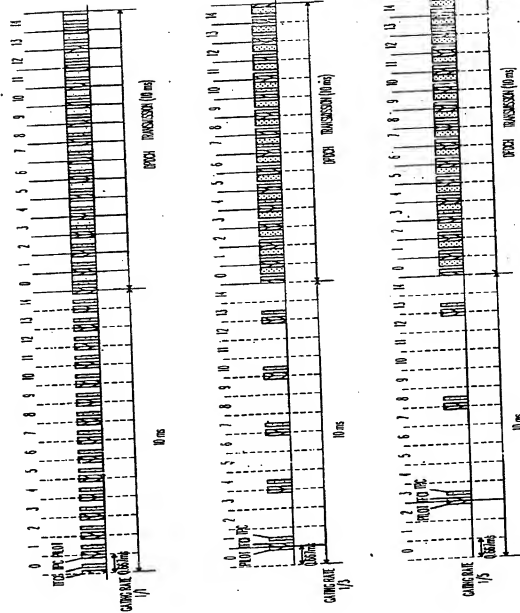


FIG. 12D

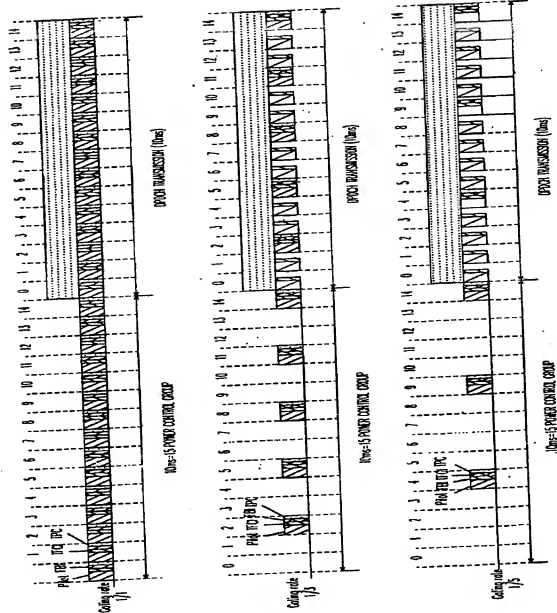


FIG. 12E

European Patent
Office

EUROPEAN SEARCH REPORT

Application Number
EP 03 01 9386

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